Appendix D
Fate and Transport Evaluation

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LIST OF ACRONYMS

DCE	dichloroethene
DHE	dehalococcoides ethenogenes
CVOC	Chlorinated volatile organic compound
ft/day	Feet per day
PCE	tetrachloroethene
TCE	tricholoroethene
VC	vinyl chloride

1.0 INTRODUCTION

The Hookston Station Feasibility Study provides analyses of a broad range of remedial alternatives. The effectiveness of these alternatives depends on a variety of physical and chemical characteristics of the site, such as the geologic and hydrogeologic characteristics of the aquifer, the physical and chemical properties of the soil, and the metabolic capabilities of native microbes. This appendix provides the results of the contaminant fate and transport analysis conducted for Hookston Station. One of the primary objectives of this analysis is to provide attenuation rate constants for ground water modeling of the various remedial alternatives.

There are four major processes affecting dissolved contaminant fate and transport:

- **Advection** – The transport of solutes by the bulk movement of ground water;
- **Dispersion** – The longitudinal and transverse spreading of a solute plume, caused by both molecular diffusion and mechanical dispersion;
- **Sorption** – The process in which molecules become fixed (sorbed) to the aquifer matrix;
- **Volatilization** – The process in which molecules transfer from a liquid state (in ground water) to a vapor state (in soil gas); and
- **Degradation** – Includes both biological and abiotic breakdown of volatile organic compounds.

In order for a solute transport model to quantitatively estimate the concentration of a plume and its rate of travel, the above processes must be quantified within the framework of the model. This memorandum presents the parameter calculation methods and results, using site-specific data where appropriate.

The Section 2 of this appendix describes these attenuation mechanisms in detail. Section 3 describes site-specific evidence of plume degradation. Section 4 provides the attenuation calculations that are used for solute transport modeling, and Section 5 provides conclusions from this analysis.

2.0 CONTAMINANT FATE AND TRANSPORT MECHANISMS

The following section provides a description of the various contaminant fate and transport mechanisms that were evaluated for Hookston Station.

2.1 ADVECTION

Ground water gradient and flow direction information is well documented within existing quarterly ground water monitoring reports and other site investigation reports. In general, ground water flows from the south of the study area toward the north to northeast at an average hydraulic gradient of 0.004 feet vertically per foot horizontally (feet/foot) (gradients are generally similar among the various aquifer units). The advective (linear) ground water flow velocity can be estimated using the following formula:

$$v_x = \frac{K}{n_e}\frac{dH}{dL}$$

where,

- v_x = Advective ground water velocity [L/T]
- K = Hydraulic conductivity [L/T]
- n_e = Effective porosity [L^3/L^3]
- dH/dL = Hydraulic gradient [L/L]

Based on a representative hydraulic conductivity of 5 feet per day (ft/day) for the A-Zone and 50 ft/day for the B-Zone (Appendix G), an average hydraulic gradient of 0.004 feet/foot, and a measured effective porosity of 0.21 for the aquifer sands (Appendix F), the average advective ground water flow velocity is approximately 40 feet per year in the A-Zone and 300 feet per year in the B-Zone. It should be noted that the hydraulic conductivity calculations provided in Appendix G range from 2 to 40 ft/day in the A-Zone, and from 4 to 153 ft/day in the B-Zone (based on different individual well tests), so although the values described above are believed to be representative of the Hookston Station Parcel and downgradient study area, a range of potential seepage velocities are expected within this flow system. Detailed three-dimensional ground water flow directions, gradients, and velocities are simulated with the ground water flow model (Appendix I). A more detailed evaluation of ground water flow rates will, therefore, not be addressed within this memorandum. The estimated seepage velocity estimates are provided herein because they are used in the calculation of degradation rate as described further below.

2.2 DISPERSION

Longitudinal dispersivity (α_x), which is a measure of the "spread" of the plume, was estimated based on a formula developed by Xu and Eckstein (1995) that uses a weighted best fit of field data, with the units of L_p and α_x adjusted from meters to feet [1] :

$$\alpha_x = 3.28 \times 0.83 \left(\log \frac{L_P}{3.28} \right)^{2.412}$$

where:

- α_x = Longitudinal dispersivity [L (ft)]
- L_p = Plume length [L (ft)]

As shown in Table D-5, a longitudinal dispersivity of 15.9 feet was calculated for the A-Zone, and a longitudinal dispersivity of 16.5 feet was calculated for the B-Zone. Transverse dispersivities are assumed to be one third of the longitudinal dispersivity (American Society for Testing and Materials 1995; United States Environmental Protection Agency [USEPA] 1986) and vertical dispersivities are assumed to be one tenth of longitudinal dispersivity (USEPA 1986).

2.3 SORPTION

Sorption is an important component to a solute transport model, as it causes slowing (or "retardation") of organic compounds relative to the advective ground water flow velocity. Organic carbon and clay mineral fractions generally act as sites of adsorption, and therefore, the more organic carbon and clay minerals in an aquifer, the slower an organic compound plume will travel relative to the advective ground water velocity.

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[1] Xu, M., and Eckstein, Y., 1995, *Use of Weighted Least-Squares Method in Evaluation of the Relationship Between Dispersivity and Field Scale*, Ground Water, November 1995.

Sorption is quantified as a coefficient of retardation (R), which can be expressed as a function of the distribution of an organic compound between the aquifer matrix and the aqueous phase:

$$R = 1 + \left(\frac{\rho_b \cdot K_d}{n} \right)$$

where:

- R = Coefficient of retardation
- ρ_b = Bulk density of the aquifer matrix [M/L^3]
- K_d = Distribution coefficient [L^3/M] [= sorbed concentration/dissolved concentration]
- n = Porosity [L^3/L^3]

The distribution coefficient (K_d) can also be expressed as:

$$K_d = K_{oc} \cdot f_{oc}$$

where:

- K_d = Distribution coefficient [L^3/M]
- K_{oc} = Soil sorption coefficient [L^3/M]
- f_{oc} = Fraction of organic carbon (milligram [mg] of organic carbon/mg of soil)

As shown in the above equation, sorption is proportional to the amount of organic carbon within the aquifer. As described in Appendix F, site-specific testing of aquifer sands identified that generally low to non-detectable levels of organic carbon were present. As a conservative assumption, no retardation via sorption was applied to the modeled plume.

2.4 *VOLATILIZATION*

Because of the fine-grained nature of the vadose zone, a significant mass transfer out of the ground water system through volatilization is not expected. However, the migration of volatile organic compounds through the vadose zone is relevant to the cleanup duration timeframe estimates, as vapor intrusion is one of the complete exposure pathways. In theory, once ground water cleanup has occurred, a lag time will occur between this cleanup time and the time in which those effects will be observed at the ground surface, where vapor intrusion into indoor air has been observed. Attachment A presents the results of vadose zone calculations, which shows that there will be an approximate 1 year lag between when ground water concentrations reach acceptably low levels (below 530 micrograms per liter, the ground water Environmental Screening Level for protection of indoor air for vapor intrusion concerns) and when indoor air concentrations would be reduced to acceptable levels. For the purpose of the solute transport model, no loss of mass is assumed through volatilization of the plume.

2.5 DEGRADATION OF CVOCS

Chlorinated volatile organic compounds (CVOCs) may undergo biodegradation by three different methods: use as electron acceptors, use as electron donors, or through cometabolism. Although one or more of these processes may occur at a site at any given time, natural conditions appear to favor the use of CVOCs as electron acceptors. This process, also known as reductive dechlorination, provides energy for the growth of the microorganisms facilitating the electron transfer. In this case, biodegradation of CVOCs is likely an electron-donor-limited process. The three methods by which biodegradation of CVOCs can occur are discussed in the following sections.

Chlorinated solvents such as PCE are known to undergo a variety of microbially mediated biodegradation reactions (Mohn and Tiedje 1992). In anaerobic environments, PCE can undergo reductive dechlorination, whereby PCE is reduced to TCE, TCE to cis-1,2-DCE, cis-1,2-DCE to VC, and VC to benign end products such as ethene, carbon dioxide, water and chloride (Figure D-1). A variety of microorganisms reduce the highly chlorinated compounds PCE and TCE to cis-1,2-DCE. However, *complete dechlorination* is defined as reduction of these parent compounds to ethene, and these reactions require specific halo-respiring bacteria.

A number of anaerobic, halo-respiring bacteria have been identified in the environment that will degrade TCE to cis-1,2-DCE. But only one type of bacteria, *dehalococcoides ethenogenes* (or DHE), is reported to catalyze the dechlorination of cis-1,2-DCE to VC. Because DHE is not always present in the subsurface environment, samples from the site were analyzed for the presence of various delahogenating microbes, including DHE.

Chlorinated solvents can also be abiotically degraded by naturally occurring reduced iron minerals. A brief description of abiotic degradation pathways is provided at the end of this section.

2.5.1 *CVOCs as Electron Acceptors*

In general, reductive dechlorination of chlorinated ethenes occurs by dechlorination from tetrachloroethene (PCE) to trichloroethene (TCE) to dichloroethene (DCE) to vinyl chloride (VC) to ethene as chlorine atoms are removed and replaced with hydrogen atoms (Figure D-1). Unfavorable environmental conditions for reductive dechlorination may interrupt this sequence, allowing other biological processes to act on the daughter products. Reductive dechlorination of CVOCs results in the accumulation of sequential daughter products along with an increase in chloride ion concentrations. The most susceptible compounds to reductive dechlorination are those that are most highly chlorinated or most oxidized. Of the chlorinated ethenes, PCE is the most susceptible to reductive dechlorination and VC is the least susceptible. During reductive dechlorination, all three isomers of DCE (cis-1,2-DCE; trans-1,2-DCE; and 1,1-DCE) can theoretically be produced; however, when they are daughter products, cis-1,2-DCE is more prevalent than trans-1,2-DCE, and 1,1-DCE is the least prevalent of the three isomers. Since the chlorinated hydrocarbon is used as an electron acceptor during reductive dechlorination, rather than as a carbon source, an alternate source of carbon is required for this process to occur. Potential sources of carbon include native organic matter or other organic sources such as petroleum hydrocarbons.

2.5.2 *CVOCs as Electron Donors*

Although PCE and TCE are not typically used as electron donors, under aerobic and some anaerobic conditions, the less oxidized CVOCs, such as VC, can be used by microorganisms as primary substrates, or sources of both energy and organic carbon. Evidence exists of the mineralization of VC under iron-reducing conditions, provided that sufficient bioavailable iron (III) is present. Aerobic biodegradation of VC may be characterized by a loss of VC mass and a decreasing ratio of moles of VC to moles of other CVOCs.

2.5.3 *Biodegradation by Cometabolism*

When CVOCs undergo biodegradation through cometabolism, the compounds are degraded by enzymes fortuitously produced by microorganisms for other purposes. The organism does not use the CVOCs as sources of carbon or energy. It has been reported that under aerobic and anaerobic conditions, chlorinated ethenes, with the exception of PCE, are susceptible to cometabolic degradation.

2.5.4 *Abiotic Degradation of CVOCs*

At sites with naturally occurring reduced iron (i.e., magnetite) or at sites with iron-rich mineralogy and strong reducing conditions, ferrous iron minerals are present and can degrade chlorinated solvents without the corresponding production of common biological daughter products such as 1,1-dichloroethane from 1,1,1-trichloroethane or cis-DCE and vinyl chloride from PCE and TCE. The chemical reaction is similar to that produced by zero-valent iron, which is commonly used in permeable reactive barriers to treat chlorinated solvents.

3.0 EVIDENCE OF PLUME DEGRADATION

3.1 GEOCHEMICAL INDICATORS FOR BIODEGRADATION OF CVOCS

The geochemical ground water data collected from A- and B-Zone monitoring wells indicate that biodegradation has advanced to different degrees throughout the ground water plumes, depending on the availability of electron donor, carbon source, and the geochemistry of the ground water.

Based on the presence and distribution of cis-1,2-DCE and 1,1-DCE (byproducts of biodegradation of PCE and TCE), biodegradation has developed to some degree in both the A- and B-Zone ground water. Biodegradation appears to be more developed in A-Zone ground water in the northwestern portion of the site where a man-made carbon source (petroleum hydrocarbons from the adjacent gasoline station) is present. Biodegradation is less developed in the B-Zone and in other areas of the A-Zone where man-made carbon sources have not been identified.

Ground water samples that were collected in April 2004 were analyzed for monitored natural attenuation parameters (e.g., sulfate, nitrate, chloride, iron, etc.) (Table D-1). Additional field data were collected in June 2006 (oxidation reduction potential, pH, dissolved oxygen, temperature, and specific conductivity) (Table D-2). Based on these recent data, conditions in both ground water zones appeared to be mildly oxidizing to mildly reducing (with an overall average of mildly reducing), with highly reducing conditions is select areas. These results are typical of mature ground water plumes undergoing some degree of biodegradation.

3.2 BIOLOGICAL INDICATORS FOR BIODEGRADATION OF CVOCS

Soil samples collected from one boring (TW-1) located in the northern portion of the site were analyzed to evaluate the presence and activity of the dehalogenating microbes responsible for each step of the sequential dechlorination of TCE to ethene. The laboratory results for this analysis are provided in Attachment B. The duplicate samples, A and B, contained 1,700 and 6,300 gene copies of DHE per gram. In the sample with the lower DHE count, the genes responsible for production of the reductive enzyme (reductase) of TCE and VC were absent. In the sample B, moderate levels of the TCE reductase and higher levels of VC reductase were found. This suggests that a dehalogenating population of microbes that are capable of complete reductive dechlorination is present in this portion of the site and, based upon the current population density, is active.

4.0 CALCULATION OF ATTENUATION FACTORS FOR MODELING

The following approaches were used to quantify the rate of attenuation and the extent of biodegradation:

- The first approach involves calculation of a bulk attenuation rate which allows for the estimation of a first-order rate constant for biodegradation alone, after accounting for the effects of non-destructive processes such as volatilization, dilution, dispersion, and sorption; and
- The second approach includes estimation of a mass loss rate from a calculation of the difference in contaminant mass flux across two parallel transects, one in the source, and one at the downgradient edge of the plume. This approach provides an estimate of the mass lost through attenuation of the plume.

These calculation methods and results are discussed in greater detail in the subsequent subsections.

4.1 BULK ATTENUATION AND FIRST ORDER RATE CONSTANTS

To predict plume chemodynamics and to determine biochemical reaction rate characteristics for CVOCs, it is often necessary to calculate site-specific biodegradation rates. Typically, degradation along flow paths approximates a first-order process.

This method uses an empirical relationship to calculate approximate first-order biodegradation rate constants for steady-state plumes. This method involves coupling the regression of contaminant concentration (plotted on a logarithmic scale) versus distance downgradient (plotted on a linear scale) to an analytical solution for one-dimensional, steady-state contaminant transport that includes advection, dispersion, sorption, and biodegradation. The effects of volatilization on the dissolved CVOC plume are assumed to be negligible. For a steady-state plume, the first-order biological decay rate is given by (Buscheck and Alcantar 1995):

$$\lambda = \frac{v_c}{4\alpha_x}\left(\left(1 + 2\alpha_x\left(\frac{k}{v_x}\right)\right)^2 - 1\right)$$

where:

k/v_x = Negative slope of line formed by making a log-linear plot of contaminant concentration versus distance downgradient along the flow path ($feet^{-1}$)

α_x = Longitudinal dispersivity (feet)

Longitudinal dispersivity is given by (Xu and Eckstein 1995):

$$\alpha_x = 3.28 * 0.83 \left(\text{Log } \left(\frac{Lp}{3.28}\right) \right)^{2.414}$$

where:

Lp = Length of plume (feet)

The log-linear plots of contaminant concentration versus distance downgradient along the flow paths for the A- and B-Zones are provided in Tables D-3 and D-4, respectively.

An estimate of the bulk attenuation rate for the the A-Zone was performed. CVOC concentrations versus distance downgradient from a selected location are plotted to evaluate bulk attentuation rates. The calculated attenuation rate for TCE was 1E-04 day^{-1} for the A-Zone and 2.4E-04 day^{-1} for the B-Zone (Table D-5). Using the Buscheck and Alcantar equation, biodegradation rate half-lives were calculated to be 19 years for TCE in the A-Zone and 4 years for TCE in the B-Zone. These values were used for biodegradation rates within the solute transport model.

4.2 MASS LOSS RATE

This approach estimates the intrinsic capacity for degradation of CVOCs by estimating the mass loss rate based solely on mass balance calculations. For a stable plume (where plume dimensions do not change with time), the difference in chemical flux across lines drawn perpendicular to the ground water flow direction, located in the source area and near the downgradient plume margin, provides quantification of net chemical loss from destructive (microbial degradation) and non-destructive (volatilization, dilution, dispersion, and sorption) processes. Mass loss calculations are performed as follows:

1. Draw chemical isoconcentration contours for chemicals of concern;

2. Draw lines perpendicular to the flow direction in the source area and in the downgradient area of the plume;

3. Using aquifer thickness, plume width, and contaminant velocity and concentration, estimate the mass of chemicals traveling across each line; and

4. Compare the mass flux calculations to estimate the chemical mass lost due to both destructive and non-destructive processes;

4.2.1 Mass Loss Calculation Results – A-Zone

The overall mass loss across the A-Zone plume was also calculated between transects established across the Hookston Station source area (Transect I), the on-site portion of the Vincent Road source area plume (Transect II), and the downgradient edge of the 500 micrograms per liter TCE A-Zone contour (Transect III). The locations of these transects are shown on Figure D-2. Based on this calculation, the mass lost across the transects is 12 pounds per year (lbs/yr) ([Transect I flux + Transect II flux) - Transect III flux)] (Table D-6). The total mass flux from the A-Zone Hookston Station and the Vincent Road source areas was estimated to be 20 lbs/yr. This indicates that 62 percent of the original mass flux from the two source areas is attenuated (through a variety of chemical, physical, and biological processes) during downgradient migration.

4.2.2 Mass Loss Calculation Results – B-Zone

The overall mass loss across the B-Zone plume was calculated between transects established across the on-site source area and the downgradient portion of the B-Zone plume; the locations of the transects are included on Figure D-3. The total mass flux from the on-site B-Zone source area was estimated to be 300 lbs/yr. The mass lost calculated between the two transects was calculated to be 60 lbs/yr, indicating that approximately 20 percent of the original mass flux from the on-site B-Zone source area is attenuated during downgradient migration (Table D-7). Mass contributions to the B-Zone plume from the off-site Vincent Road source area were not accounted for in this analysis due to the scarcity of data from for that source. The absence of data from this area would therefore produce an understimate of the mass lost through natural attenuation processes, as this analysis did not include this potential supplemental source. Additional investigations into this off-site source area by the responsible parties will better define the impacts of this source to the overall ground water plume.

4.0 CONCLUSIONS

The conclusions of the fate and transport analysis are summarized below:

- Ground water seepage velocities range from approximately 40 to 300 feet per year within the study area, although localized areas of higher or lower flow velocities are present. Contaminant velocities are typically lower than ground water seepage velocities due to a number of attenuation mechanisms.
- Reductive dechlorination is occurring within the A- and B-Zone ground water plumes. It is most notably observed in the A-Zone in the northwestern portion of the site. The dechlorination is likely due to favorable geochemistry and the presence of microbial population (the presence of which was confirmed with site-specific microbial analyses).
- Calculations using A-Zone plume data indicate that 61 percent of the original mass flux from the Hookston Station and Vincent Road source areas is attenuated during downgradient migration.
- Calculations using B-Zone plume data indicate that approximately 20 percent of the original mass from the Hookston Station source area is attenuated during downgradient migration. This evaluation may underestimate the total amount of mass loss through attenuation, as sufficient data regarding B-Zone impacts from the Vincent Road source area and other potential source areas are not currently available.
- Based on bulk attenuation rated using site-specific data, the solute transport model (Appendix I) will apply a biodegradation half-life of 19 years for TCE in the A-Zone and 4 years for TCE in the B-Zone. The modeling will also include dispersion based on site-specific data, but will not include retardation due to sorption or mass loss due to volatilization.

5.0 REFERENCES

Buschek, T.E. and Alcantar, C.M. 1995. Regression techniques and analytical solutions to demonstrate intrinsic bioremediation, In *Proceedings of the 1995 Battelle International Conference on In-Situ and On Site Bioremediation*. April 1995.

United States Environmental Protection Agency (USEPA). *Anaerobic Biodegradation Rates of Organic Chemicals in Ground water: A Summary of Field and Laboratory Studies*. June 1999.

USEPA. *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water*. USEPA/600/R-98/128. September 1998.

Mohn, W.W. and J.M. Tiedje. 1992. Microbial Reductive Dehalogenation. *Microbiol. Rev.* 56,482-507.

Figures

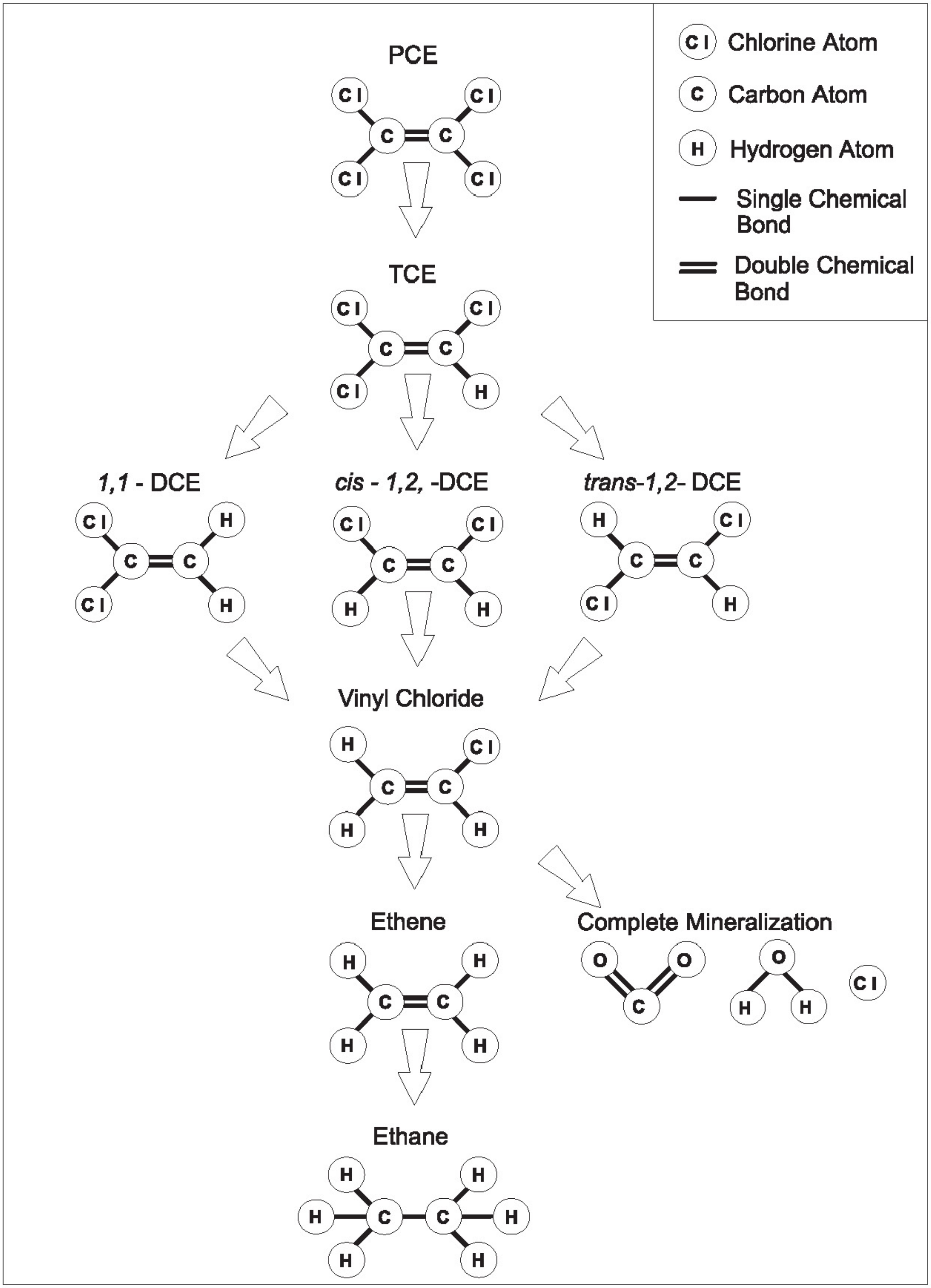

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Figure D-1
Reductive Dechlorination of PCE
Hookston Station
Pleasant Hill, California

ERM *06/06*

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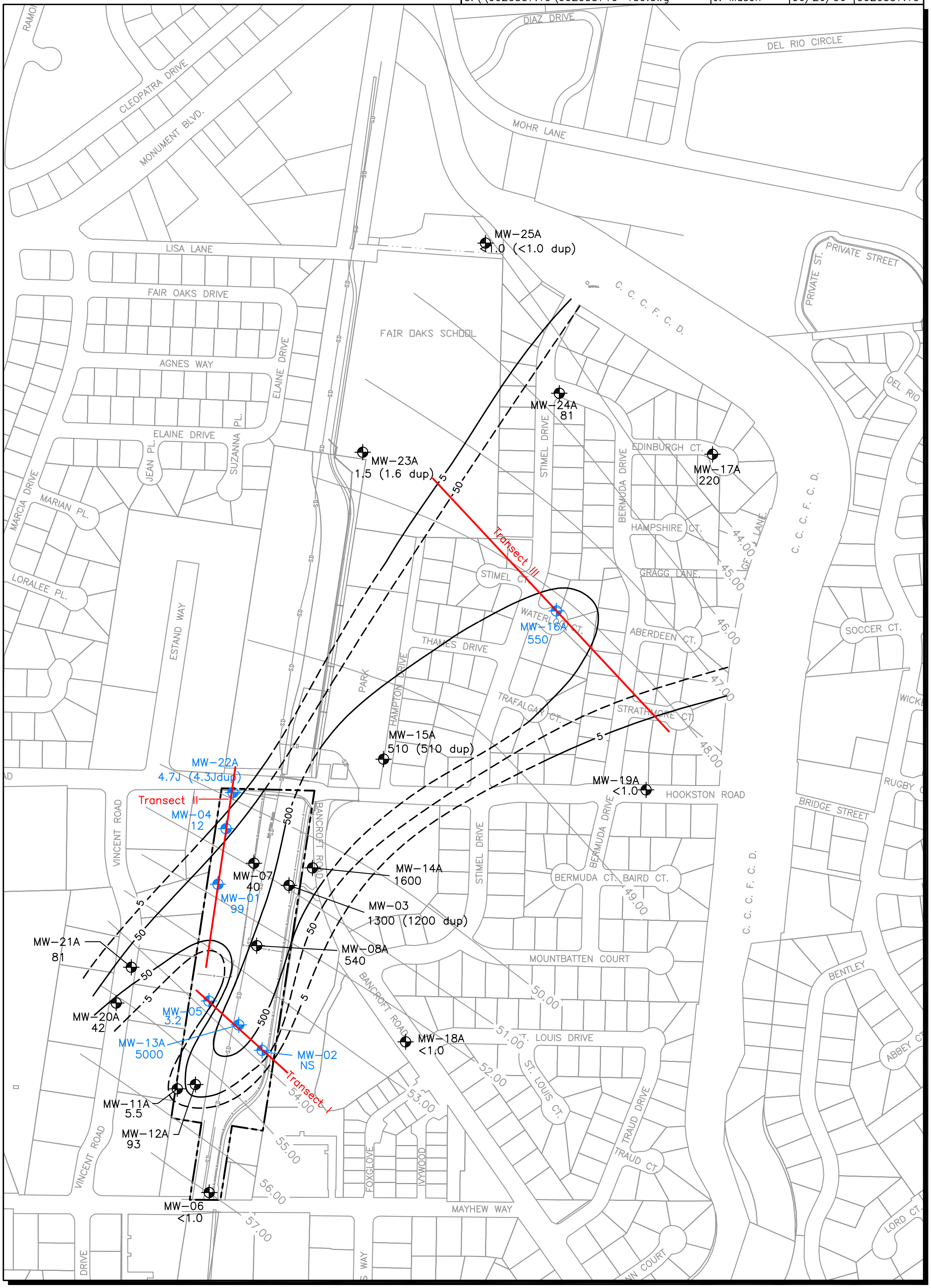

LEGEND

- Monitoring Well Location
- Indicates Well Included in Mass-Flux Analysis
- 5.5 TCE Concentration (μg/L)
- 50 TCE in Ground Water Contour, Solid Based on First Quarter 2006 Monitoring Well Data, Dashed Where Inferred from Off-Site Investigation Data or Historical Grab Ground Water Sampling.
- Hookston Station Parcel Property Boundary
- 53.00 Ground Water Elevation Contour, A-Zone, January 2006 (feet above mean sea level)
- J Estimated Values
- NS Not Sampled
- * Not Used for Contouring Based on Historical Data

The Maximum Contaminant Level For TCE in Drinking Water is 5 μg/L.
Note: MW-07 Data Not Used for Contouring Purposes.

0 300
FEET

Figure D-2
Mass-Flux Analysis Transects
A Zone Ground Water
First Quarter 2006
Hookston Station
Pleasant Hill, California

ERM *06/06*

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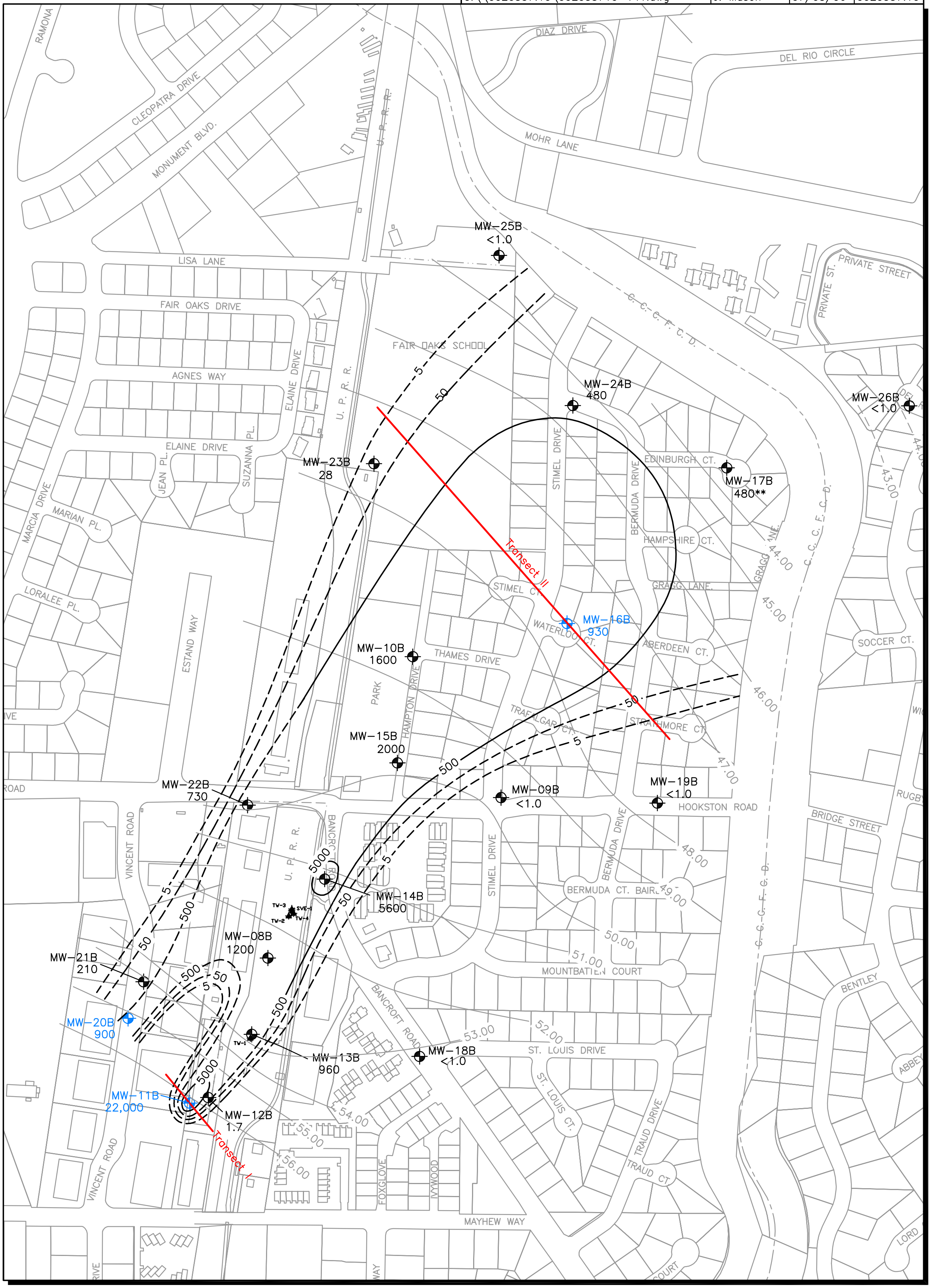


LEGEND

(well symbol)	Monitoring Well Location
(blue well symbol)	Indicates Well Included in Mass-Flux Analysis
59	TCE Concentration (μg/L)
50 ———	TCE in Ground Water Contour, Solid Based on First Quarter 2006 Monitoring Well Data, Dashed Where Inferred from Off-Site Investigation Data or Historical Grab Ground Water Sampling.
— · — · —	Hookston Station Parcel Property Boundary
51.00 ———	Ground Water Elevation Contour, B-Zone, January 2006 (feet above mean sea level)
**	Multiple Samples Were Collected at Various Depths Within the Well Screen. The Highest Result is Posted

The maximum contaminant level for TCE in drinking water is 5 μg/L

N

0 300
FEET

Figure D-3
Mass-Flux Analysis Transects
B Zone Ground Water
First Quarter 2006
Hookston Station
Pleasant Hill, California

ERM *07/06*

Tables

Table D-1
General Minerals, Water Quality, and Natural Attenuation Parameters in Ground Water
Hookston Station
Pleasant Hill, California

Sample Location	Date	Sample Depth	Analytical Laboratory	Preparation Fraction	ALKALINITY, TOTAL AS CAC03 (mg/L) MCAWW 310.1	CHLORIDE (mg/L) MCAWW 300.0		HARDNESS (mg/L) SM18 2340B		POTASSIUM (mg/L) SW846 6010B		TOC (mg/L) MCAWW 415.1		IRON (mg/L) SW846 6010B		MANGANESE (mg/L) SW846 6010B		NITRATE, NITROGEN (mg/L) MCAWW 300.0		SULFATE (mg/L) MCAWW 300.0		CARBON DIOXIDE (mg/L) RSK 175		ETHANE (µg/L) RSK 175	ETHENE (µg/L) RSK 175	METHANE (mg/L) RSK 175	
MW-01	4/20/2004	10-20	STL Sac	Total	553	72.2	q	746		10.4		3.6						1.5		135	q						
MW-03	4/20/2004	10-20	STL Sac	Total	719	177	q	1720		21.4		4		0.27		0.0072		2.2	q	190	q	82			NS	0.001	U
MW-04	4/21/2004	11-21	STL Sac	Total	737	212	q	893		9.0		4.4						1.6		184	q						
MW-04 Duplicate	4/21/2004	11-21	STL Sac	Total	750	218	q	863		8.4		4.8						1.5		183	q						
MW-05	4/20/2004	10-30	STL Sac	Total	785	129	q	1010		8.9		3						2.4	q	235	q						
MW-06	4/20/2004	15-35	STL Sac	Total	783	197	q	1020		6.3		3.2				NS		2.5	q	251	q						
MW-07	4/20/2004	15-35	STL Sac	Total	751	155	q	874		3.7		2.6						0.83		262	q						
MW-08A	4/21/2004	10-25	STL Sac	Total	786	195	q	869		1.5		3		0.06	b	0.095		1.7		289	q	110				0.001	U
MW-08B (previously MW-01D)	4/20/2004	45-60	STL Sac	Total	64.8	62.4	q	198		2.3		2.5		0.064	b	0.0042	b	0.52		22.8	q	0.68				0.001	U
MW-08B dup (previously MW-01D)	4/20/2004	45-60	STL Sac	Total	67.0	61.8	q	195		2.3		2.5		0.074	b	0.0065		0.54		22.2	q	0.65				0.0011	U
MW-09B (previously MW-02D)	4/27/2004	50.5-60.5	STL Sac	Total	369	110	Qj	507		4.8		2						0.97		< 10	uq						
MW-10B (previously MW-03D)	4/26/2004	40-50	STL Sac	Total	153	29.2	q	155		21.1		17.2						4.0	qJ	33.8	QjJ						
MW-10B dup (previously MW-03D)	4/26/2004	40-50	STL Sac	Total	160	31.5	q	143		21.0		16.7						4.1	qJ	35.0	QjJ						
MW-11A	4/27/2004	10-25	STL Sac	Total	743	158	qJ	746		2.0		3.6		0.36		0.12		< 0.5	u	198	qJ	97				0.03	b
MW-11B	4/27/2004	40-50	STL Sac	Total	536	347	qJ	672		1.3		2		0.093	b	2.5		< 0.5	u	124	qJ	61				0.0012	bU
MW-12A	4/27/2004	10-25	STL Sac	Total	601	109	qJ	667		2.2		2.4		< 0.1	u	0.077		5.2	q	171	qJ	88				< 0.001	u
MW-12B	4/27/2004	50-60	STL Sac	Total	498	277	qJ	602		1.3		2.4		0.11		1		< 0.5	u	82.6	qJ	60				0.0011	bU
MW-13A	4/21/2004	18-33	STL Sac	Total		135	q	640		1.1		3.2		0.019	b	1		1.1		152	q	77				0.035	b
MW-13B	4/22/2004	45-55	STL Sac	Total	644	168	q	626		1.9		4.6	j	< 0.1	u	0.94		0.48	bJ	198	q	57				0.024	
MW-14A	4/28/2004	29-34	STL Sac	Total	462	223	qJ	881		10.3		5.9	j	0.075	b	0.87		< 0.5	u	160	qJ	25				0.0019	bU
MW-14B	4/28/2004	40-50	STL Sac	Total	382	180	qJ	312		9.8		1.9	j	< 0.1	u	0.01		1.4		120	qJ	4				0.0011	bU
MW-15A	4/22/2004	14.5-24.5	STL Sac	Total	781	228	q	1250		19.9		4.1	j	< 0.1	u	0.11		2.1	qJ	227	q	110				0.011	
MW-15B	4/23/2004	49-59	STL Sac	Total	538	216	q	535		5.7		14.8	j	< 0.1	u	0.17		0.56	J	162	q	35				0.0018	
MW-15C	4/22/2004	90-95	STL Sac	Total	373	156	q	402		2.7		2.1	j	NS				< 0.5	uR	61.7	q						
MW-16A	4/27/2004	15-25	STL Sac	Total	472	160	qJ	877		12.5		4.1		0.035	b	0.19		1.8	q	164	qJ	7.9				0.058	b
MW-16B	4/26/2004	35-45	STL Sac	Total	150	174	q	181		16.1		5.4		< 0.1	u	0.0015	b	0.56	J	169	qJ	< 0.17	u			0.002	bU
MW-17A	4/27/2004	20.7-30.7	STL Sac	Total	575	169	qJ	930		11.5		2.5		0.094	b	0.031		16.3	q	135	qJ	110				0.0011	bU
MW-17B	4/27/2004	44-54	STL Sac	Total	450	160	qJ	571		2.9		2.1		< 0.1	u	0.023		3.0	q	119	qJ	25				0.001	U
MW-18A	4/28/2004	14.7-24.7	STL Sac	Total	904	178	qJ	1060		14.7		3.1	j					3.5	q	213	qJ						
MW-18B	4/28/2004	32-42	STL Sac	Total	672	179	qJ	788		2.1		4	j					1.6	q	206	qJ						
MW-19A	4/28/2004	14-24	STL Sac	Total	655	111	qJ	866		18.1		2.2	j					< 1	uq	139	qJ						
MW-19B	4/28/2004	29-39	STL Sac	Total	618	193	qJ	799		4.9		2.4	j					5.1	q	179	qJ						
MW-19C	4/28/2004	70-80	STL Sac	Total	370	166	qJ	402		2.4		3.4	j					< 0.5	u	58.7	qJ						
MW-19C Duplicate	4/28/2004	70-80	STL Sac	Total	376	159	qJ	399		2.3		3.3	j					< 0.5	u	56.0	qJ						
MW-20A	4/22/2004	10-20	STL Sac	Total	469	121	q	1090		20.5		2.4	j					2.0	qJ	135	q						
MW-20B	4/22/2004	30.5-40.5	STL Sac	Total	428	97.2	q	557		4.8		2.5	j					< 0.5	uR	196	q						
MW-21A	4/21/2004	10-20	STL Sac	Total	710	175	q	1770	g	34.4	g	3.9						2.2	q	224	q						
MW-21B	4/21/2004	29-39	STL Sac	Total		135	q	742		6.8		2.5						1.4		222	q						
MW-22A	4/21/2004	15-25	STL Sac	Total	1020	175	q	1590		24.4		6.1						< 0.05	u	89.4	q						
MW-22B	4/21/2004	40-50	STL Sac	Total	716	240	q	980		7.8		5						< 0.05	u	243	q						
MW-24A	4/27/2004	19.5-29.5	STL Sac	Total	598	126	qJ	888		13.2		2.6						3.3	q	149	qJ						
MW-24B	4/27/2004	39.5-49.5	STL Sac	Total	610	230	qJ	789		5.2		6.7						< 0.5	u	219	qJ						
MW-26B	4/28/2004	40-50	STL Sac	Total	472	79.5	qJ	638		6.9		13	j	0.017	b	0.076		7.2	q	187	qJ	53				0.001	U

Notes:
# = Maximum of multiple analytical results
u = Compound was analyzed for but not detected. Analyte result was below the Reporting Type Limit.
d = Result from an analysis at a secondary dilution factor.
b = ORG: Compound is found in the associated blank as well as in the sample. INORG: Value less than contract required detection limit but greater than or equal to instrument detection limit.
g = Elevated reporting limit due to matrix interference
j = Estimated Value
q = Elevated reporting limit due to high analyte levels
NS = Not Sampled
< = Not Detected
Bicarbonate, carbonate, and hydroxide alkalinity were also analyzed during 1st Quarter 2001 but are not reported on this table.

Laboratories:
CTBERK = Curtis&Thompkins Berkley
STL Sac = Severn Trent Laboratory, Sacramento

Abbreviation Chemical
TOC = TOTAL ORGANIC CARBON

Table D-2
Field Parameter Data
Hookston Station
Pleasant Hill, California

Well ID	Date Sampled	Screen Interval (ft bgs)	Gallons Removed	Temp °C	pH	Conductivity (μg/cm)	ORP mV	DO mg/L
A-Zone								
MW-1	9 Jun 06	10-25	0.7	19.38	7.87	956	-81.8	0.13
MW-3	9 Jun 06	10-20	0.7	23.61	6.64	1954	-11.7	0.57
MW-4	9 Jun 06	11-21	0.6	17.36	7.37	1565	-136.7	0.16
MW-5	9 Jun 06	10-30	0.5	25.86	7.27	1569	87.9	0.26
MW-6	9 Jun 06	15-35	0.6	26.22	7.20	2185	13.5	0.20
MW-7	9 Jun 06	15-35	0.5	21.64	7.07	1500	-68.9	0.14
MW-8A	9 Jun 06	10-25	0.6	19.88	7.97	1606	6.2	0.20
MW-11A	8 Jun 06	10-25	0.6	20	7.10	1409	9.6	0.39
MW-12A	8 Jun 06	10-25	0.5	19.78	7.66	1189	-99.1	0.34
MW-13A	9 Jun 06	18-33	0.6	24.9	6.86	1347	-13.2	0.62
MW-14A	8 Jun 06	29-34	0.5	21.59	7.11	1603	-46.5	0.15
MW-15A	8 Jun 06	15-25	1.3	21.36	6.86	1841	-1.0	0.25
MW-16A	8 Jun 06	15-25	0.4	18.51	7.11	1056	-37.8	0.44
MW-17A	7 Jun 06	20.7-30.7	0.5	26.57	6.60	1710	60.3	1.42
MW-18A	7 Jun 06	15-25	0.6	21.52	6.70	1732	-30.2	0.25
MW-20A	8 Jun 06	10-20	0.5	25.36	6.90	1876	-36.6	0.19
MW-21A	8 Jun 06	10-20	0.6	24.79	6.80	1856	-52.2	0.09
MW-22A	9 Jun 06	15-25	0.5	20.75	7.09	1703	-45.3	0.20
MW-25A	7 Jun 06	18-28	0.7	20.44	6.69	1775	26.0	0.21
Average			0.6	22.08	7.10	1602	-24.1	0.33
B-Zone								
MW-8B	9 Jun 06	45-60	0.5	20.02	7.51	1561	-7.7	0.14
MW-11B	8 Jun 06	40-50	0.8	21.26	7.00	1722	-51.1	0.14
MW-12B	8 Jun 06	50-60	0.4	19.36	7.47	1529	-131.7	0.27
MW-13B	9 Jun 06	45-55	0.6	20.74	8.29	1356	-45.3	0.20
MW-14B	8 Jun 06	40-50	0.7	23.41	7.24	1573	-114.0	0.14
MW-15B	8 Jun 06	49-59	2.0	19.52	7.13	1462	-0.2	0.23
MW-16B	8 Jun 06	35-45	2.0	19.09	6.71	1605	98.0	0.22
MW-17B	7 Jun 06	44-54	0.9	21.12	6.92	1141	20.1	0.15
MW-18B	7 Jun 06	32-42	0.3	21.92	6.66	1750	38.2	0.34
MW-20B	8 Jun 06	30.5-40.5	0.7	25.6	7.25	1403	-123.8	0.15
MW-21B	8 Jun 06	29-39	0.6	23.84	7.06	1732	-26.0	0.23
MW-22B	9 Jun 06	40-50	0.6	19.5	7.15	1609	75.3	0.20
MW-25B	7 Jun 06	48-58	0.6	25.16	6.92	1800	46.9	0.97
Average			0.8	21.58	7.18	1557	-17.0	0.26

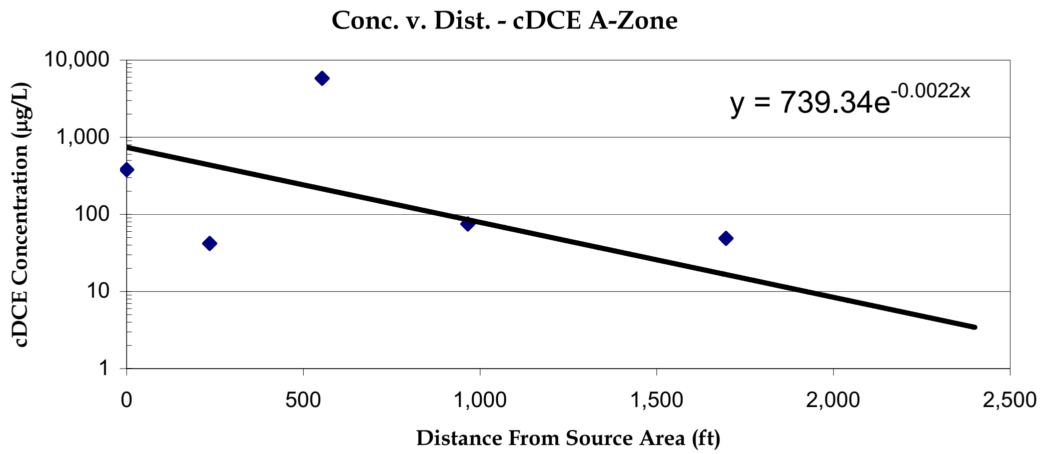
Notes:
ft bgs = feet below ground surface
°C = degrees Celsius
mS/cm = microsiemens per centimeter
mV = millivolt

Table D-3
A-Zone Bulk Attenuation Rate Calculation
Hookston Station
Pleasant Hill, California

Well ID	x (ft)	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	tDCE (µg/L)	VC (µg/L)
MW-13A	0	45	5,000	380	*50*	*50*
MW-08	234.78	*5.0*	540	42	4.1	*5.0*
MW-14A	553.04	*50*	1,600	5,800	21	1,400
MW-15A	965.22	*5.0*	510	75	2.0	*5.0*
MW-16A	1,695.7	*5.0*	550	49	*5.0*	*5.0*
MW-17A	2,400.0	*2.5*	220	0.99	*2.5*	*2.5*

Notes:

Shaded/italicized values are non-detects reported as one-half the method detection limit.
Groundwater data from January 2006 monitoring round.



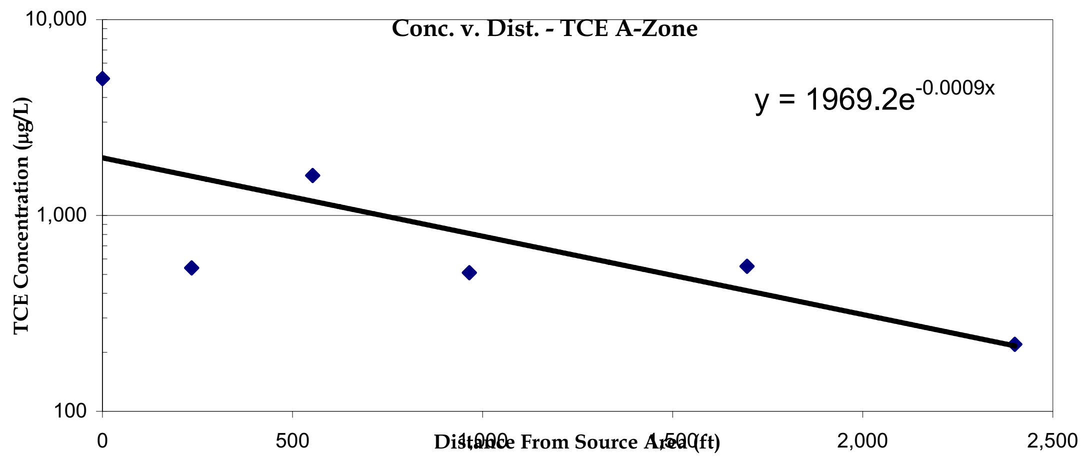
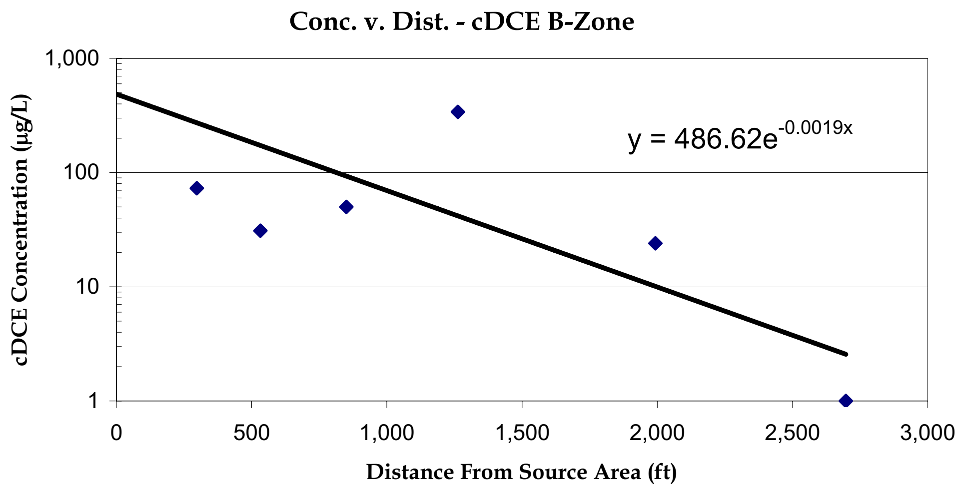


Table D-4
B-Zone Bulk Attenuation Rate Calculation
Hookston Station
Pleasant Hill, California

Well ID	x (ft)	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	tDCE (µg/L)	VC (µg/L)
MW-11B	0	*250*	22,000	2,500	*250*	*250*
MW-13B	297.4	*10*	960	73	*10*	*10*
MW-08B	532.2	*10*	1,200	31	*10*	*10*
MW-14B	850.4	*50*	5,600	*50*	*50*	*50*
MW-15B	1,262.6	*25*	2,000	340	*25*	*25*
MW-16B	1,993.1	*10*	930	24	*10*	*10*
MW-17B	2,697.4	*5.0*	480	1.0	*5.0*	*5.0*

Notes:

Shaded/italicized values are non-detects reported as one-half the method detection limit.
Groundwater data from January 2006 monitoring round.



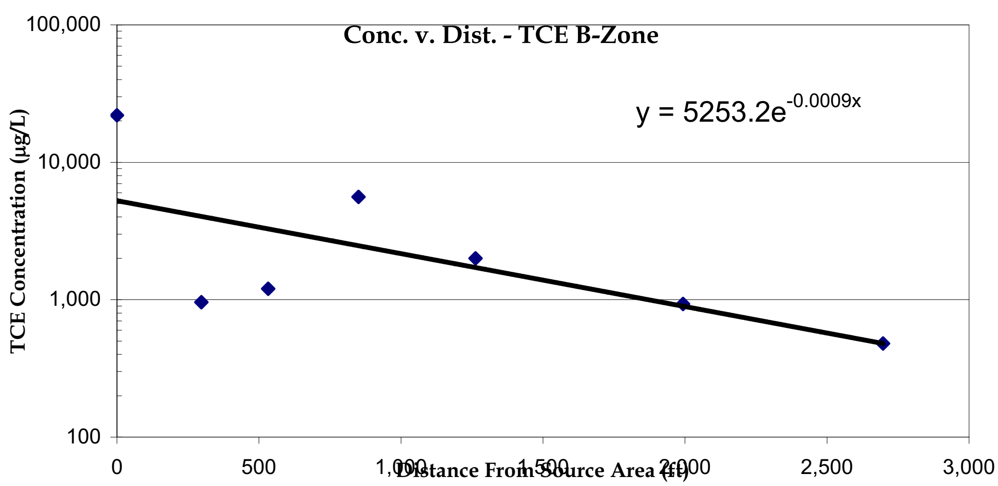


Table D-5
First-Order Degradation Rate Constants
Hookston Station
Pleasant Hill, California

	A-Zone Calculations				B-Zone Calculations			
	k/v_x (ft^{-1})	**k** (day^{-1})	**Calculated λ[1]** (day^{-1})	**Half-life** (year)	**k/v_x** (ft^{-1})	**k** (day^{-1})	**Calculated λ[1]** (day^{-1})	**Half-life** (year)
TCE	-0.0009	0.00010	-0.000098	19	-0.0009	0.00047	-0.00046	4
cis-1,2-DCE	-0.0022	0.00024	-0.000234	8	-0.0019	0.00099	-0.00096	2

Notes:

k = First order rate constant, all degradation processes.

[1] = Calculated as follows:

$$\alpha_x = 0.83(Log_{10}L_p)^{2.414} \qquad \lambda = \frac{v_c}{4\alpha_x}\left(\left[1 + 2\alpha_x\left(\frac{k}{v_x}\right)\right]^2 - 1\right) \qquad half-life\,(years) = \frac{\ln(2)}{\lambda \cdot 365}$$

Where:

Symbol	Description	A-Zone	B-Zone	Units	Source
α_x	Longitudinal dispersivity				
	TCE	15.9	16.5	ft	Calculated
	cis-1,2-DCE	14.7	16.5	ft	Calculated
L_p	Plume length				Site data
	TCE	2,500	2,800	ft	
	cis-1,2-DCE	1,950	2,800	ft	
λ	1st-order biological rate constant	See Above	See Above		Calculated
v_c	Retarded contaminant velocity	0.110	0.520	ft/day	Seepage velocity, assumed no retardation due to sorption
k/v_x	Slope of trend line	See Above	See Above		Semi-log Concentration v. Distance plot, from Tables D-3 and D-4

Table D-6
A-Zone Mass Flux Calculation
Hookston Station
Pleasant Hill, California

Transect	**Contaminant Velocity** (ft/day)	**Depth of Aquifer** (feet)	**Width of Section** (feet)	**Average Concentration** (µg/L)	**Conversion Factor**[1]	**Mass Rate Through Transect** (lb/yr)
I	0.110	16	60	27.5	2.28E-05	0.0661
	0.110	16	110	275	2.28E-05	1.213
	0.110	16	120	3,192	2.28E-05	15.35
						16.63
II	0.110	16	140	27.5	2.28E-05	0.1543
	0.110	16	270	310	2.28E-05	3.350
						3.504
				Total Transect I and II mass rate (lb/yr) =		20.13
III	0.110	10	120	27.5	2.28E-05	0.0827
	0.110	10	615	275	2.28E-05	4.24
	0.110	10	235	567	2.28E-05	3.338
				Total Transect III mass rate (lb/yr) =		7.66
				Mass rate difference (lb/yr) =		**12.48**
				Mass Loss =		**62%**

Notes:
Transect I = Mass from Hookston Station source area.
Transect II = Mass entering Hookston Station's western property boundary.
Transect III = Mass flowing through downgradient study area.
[1] = Converts (ft^3/day)*(µg/L) to lb/yr.
µg/L = micrograms per liter.
lb/yr = pounds (mass) per year.

Table D-7
B-Zone Mass Flux Calculation
Hookston Station
Pleasant Hill, California

Transect	**Contaminant Velocity** (ft/day)[1]	**Depth of Aquifer** (feet)	**Width of Section** (feet)	**Average Concentration** (μg/L)	**Conversion Factor**[1]	**Mass Rate Through Transect** (lb/yr)
I	0.520	30	32	27.5	2.28E-05	0.313
	0.520	30	26	275	2.28E-05	2.54
	0.520	30	32	2,750	2.28E-05	31.3
	0.520	30	47	16,150	2.28E-05	270
				Total Transect I and II mass rate (lb/yr) =		304
II	0.520	30	200	27.5	2.28E-05	1.954
	0.520	30	300	275	2.28E-05	29.3
	0.520	30	785	761	2.28E-05	212.1
				Total Transect II mass rate (lb/yr) =		243.4
					Mass rate difference (lb/yr) =	**60.4**
					Mass Loss =	**20%**

Notes:
Transect I = Mass from Hookston Station source area.
Transect II = Mass flowing through downgradient study area.
[1] = Converts (ft^3/day)*(μg/L) to lb/yr.
μg/L = micrograms per liter.
lb/yr = pounds (mass) per year.

Attachment A
Time Estimate for Operating Vapor Intrusion Prevention Systems

Memorandum

Environmental
Resources
Management

1777 Botelho Drive
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Walnut Creek, CA 94596
(925) 946-0455
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To: Project File

From: Arthur Taylor, Arun Chemburkar, P.E.

Date: 8 June 2006

Subject: Time Estimate for Operating Vapor Intrusion Prevention Systems

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Calculations were made for the downgradient study area to estimate incremental operation time for vapor intrusion prevention systems after the ground water remediation efforts have been reduced to concentrations that no longer warrant concern for vapor intrusion into indoor air. This memorandum describes the calculation method, assumptions made in creating the conceptual model, and the resulting durations for the residual TCE in the vadose zone (comprised of TCE mass in the pore vapor, dissolved in soil moisture and sorbed to the soil) to attenuate to levels that pose no adverse effect to human health.

INTRODUCTION

The primary chemicals of concern is trichloroethene (TCE), and will be the focus of this exercise to estimate the lag time between attaining the ground water Environmental Screening Level (ESL) of 530 µg/L and the time after which the TCE in vadose soils are expected to no longer pose a TCE vapor intrusion risk to the residents in the area of interest.

ASSUMPTIONS

For this exercise, as an overlying assumption, several soil characteristics are assumed to be homogeneous throughout the vadose zone.

Fourteen soil samples were analyzed during a geotechnical study performed on the Hookston Station Parcel. The average porosity of these samples was 43% (0.43) with a standard deviation of only 3.3%. Of these samples, six were considered to be part of the vadose zone. These samples had an average porosity and standard deviation of 42.55% and 1.93, respectively. The comparable porosities led to the decision to utilize the observed mean porosity for all the samples as the porosity for the model. The average bulk density of the same samples was 1.55 g/cm^3, with a standard deviation of 0.086 g/cm^3. Ground water depths were measured in 48 monitoring wells, some of which were installed as early as 1990. The ground water depth records for these wells yielded and average groundwater depth of 16.67 ft, with a standard deviation of 2.60 ft. A ground water depth of 16.7 ft was used to model the subsurface.

Based on the above characteristics, the following assumptions regarding the physical characteristics of the subsurface were used in the calculations:

- Homogeneous Soil Porosity = 0.43
- Homogeneous Soil Density = 1.55 kg/L
- Uniform groundwater depth = 16.7 ft.
- Volumetric water content within soil volume = 0.33
- Volumetric air content within soil volume = 0.1

Several assumptions were also made regarding the physical interactions between the groundwater, soil, and pore vapor and the interactions of their geochemical constituents. These assumptions are as follows:

- The TCE concentration is uniform in the pore vapor and soil moisture; and,
- The TCE sorbed to soil particles is capable of desorbing at a rate that is not limiting beyond the compensation factors discussed below.

To achieve a conservative estimate of the time required for the pore vapor in the vadose zone to reach clean-up concentrations, efficiency factors are incorporated into the calculations. One such factor relates to the ability of the vapor intrusion prevention system (RadonAway™ fan systems are used in the downgradient study area) to extract air from the vadose zone. We estimate that only 75% of the available airflow contains extracted air from the vadose zone and the remainder of the air estimated to have leaked in from the ground surface immediately surrounding the footprint of the home. In addition, an efficiency factor of 30% is applied when calculating the TCE concentration in the vent gas of the vapor extraction process to account for the possible decrease in TCE concentration in the pore vapor, as the migration of TCE contaminated vapor up through the soil column is likely diffusion limited.

To make this exercise straightforward, we have assumed that the beneficial effect of operation of vapor intrusion prevention systems during the ground water remedy implementation were ignored to add conservatism as well as calculation simplicity to the duration estimate.

CALCULATIONS

TCE Concentrations

Henry's Law is utilized to determine the TCE pore vapor concentration in equilibrium with the groundwater clean up goal concentration (530 µg/L or part per billion [ppb]).

$$C_{AIR} = Kh \times C_{WATER} \qquad (1)$$

where K_h is the dimensionless Henry's Law constant (0.379 for TCE). The TCE concentration in the soil vapor can thus be determined (C_{AIR} = 201 ppbv). Using the DiGiulio Method (DiGiulio, 1992) the following equation can be derived to determine the total fraction of TCE in the soil (in pore vapor, soil moisture and sorbed to the soil particles):

$$C_{SOIL}=C_{AIR}*(a*K_d/K_h+b/K_h+c)$$

where

a = bulk density (kg/L)

b = Volumetric water content within soil volume (dimensionless)

c = Volumetric air content within soil volume (dimensionless)

K_d = Distribution coefficient (L/kg)

K_h = Henry's Law constant (dimensionless)

Using the values discussed in the assumptions section above the TCE concentration sorbed to the soil can be calculated (C_{SOIL} = 223 ppb).

The portion of the downgradient study area exceeding indoor air risk is estimated to be approximately 256,000 ft^2. This number was derived from the 500 µg/L TCE in the groundwater concentration contour line, as shown in Figure 6 of the *First Quarter 2006 Monitoring Report and April 2006 Monthly Status Report*, prepared by ERM on 1 May 2006. Using the assumptions that the distance to ground water is constant and that C_{SOIL} is uniform the total mass of the TCE in the vadose zone is estimated to be 4.19×10^4 g.

TCE Flux

ERM conducted a preliminary risk evaluation of the vapor intrusion threat to the residential units in the area of interest (ERM, 2002). During this study a flux chamber was used to determine VOC fluxes both indoors and outdoors. The outdoor sampling effort yielded a TCE flux of 0.085 $\mu g \cdot m^{-2} \cdot min^{-1}$.

For the purpose of this study, approximately 20 of the homes, with footprints of 2,000 ft^2 each, in the downgradient study area will be equipped with RadonAway™ pumping systems below the house to evacuate VOCs vapors and preventing them from entering the home. A conservative estimate of the extraction rates of these pumps is 100 cubic feet per minute (CFM). An efficiency factor of 75% is used to make allowance for the possibility of air leakage from the surface. Thus, only 75 CFM of vented gas is anticipated to be drawn in from the vadose zone. As mentioned above, the TCE concentration in the pore vapor (C_{AIR}) is assumed constant throughout the soil column, and was estimated using Henry's Law to be 201 ppb_V. However, an efficiency factor of 30% is applied to this to account for the diffusion limited transport of the TCE vapor up from the water table, as discussed in the assumptions section above.

The TCE flux attributed to the RadonAway™ systems can be estimated using the following equation:

$$\frac{m}{day} = Q_v \times \frac{mw}{V} \times C_{ppmv} \times 1440(^{\min}/_{day})$$

where

Q_v = Volumetric Flux of vent gas

mw = molecular weight

C_{ppmv} = Concentration of contaminant in venting gas

resulting in a flux of 2.22×10^{-3} $^{lb}/_{day}$, which incorporates the efficiency factors discussed above in both Q_v and C_{ppmv}. The TCE flux for the remainder of the surface is estimated using the TCE surface flux measured during the *Preliminary Risk Evaluation* to be 5.43×10^{-3} $^{lb}/_{day}$.

Acceptable Levels of TCE in the subsurface

The indoor air cleanup goal, representing a 1E-06 theoretical lifetime excess cancer risk (or a Hazard Index of 1 for non-carcinogens) for residential inhalation, assuming elevated breathing rates in accordance with Water Board requirements, is 0.96 μg/m^3 for TCE. This value represents a calculated one-in-a-million lifetime excess cancer risk number that was calculated within the Baseline Risk Assessment (CTEH, 2006). Using a conservative attenuation factor of 1E-03 (concentration in indoor air/concentration in subsurface soil vapor), the concentration allowable in indoor air (0.960 μg/m^3) translates to 960 μg/m^3 of TCE allowed in the pore vapor. Using the DiGiulio Method and following similar calculations as above results in a total of 3.35×10^4 g TCE allowed in the subsurface under consideration.

Clean-up Time Estimation

Applying a first order rate equation to determine the time required to vent the TCE from the subsurface:

$$(TCE_1 - TCE_{ALLOWABLE})/(F_R + F_S) = t$$

where:

TCE_1 = Estimated starting mass of TCE in the vadose zone

$TCE_{ALLOWABLE}$ = Acceptable TCE mass in vadose zone, as discussed above.

t = time

F_R = TCE flux attributed to RadonAway™ systems

F_s = TCE flux rate of open surfaces

This equation yields an estimated clean-up lag time of approximately 368 days. This calculation neglects the impact of pavement outside the houses (e.g., roads, driveways and sidewalks). If the neighborhood is assumed to be 40% pavement and that the flux through that pavement is zero, the clean-up lag time changes by 30 days, to 398 days.

CONCLUSIONS

It is estimated that operation of vapor intrusion prevention systems (rated for 100 scfm) from 20 locations for approximately one year, will reduce TCE levels to below regulatory standards, after the groundwater remediation effort has achieved its clean-up goal.

REFERENCES

ERM, 2002. *Preliminary Risk Evaluation: Hookston Station Project, Pleasant Hill, California.* 22 October 2002.

DiGiulio, Dominic C., 1992. *Evaluation of Soil Venting Application*. Ground Water Issue, April 1992. EPA/540/S-92/004.

Attachment B
Polymerase Chain Reaction
Assay Results

2340 Stock Creek Blvd.
Rockford TN 37853-3044
Phone: (865) 573-8188
Fax: (865) 573-8133
Email: info@microbe.com

Analysis Report

Client: Mike Lee
Terra Systems, Inc.
1035 Philadelphia Pike
Suite E
Wilmington, DE 19809

Phone: (302) 798-9553

Fax: (302) 798-9554

MI Identifier: 031DD **Date Rec:** 04/19/2006 **Report Date:** 04/20/2006

Client Project #: **Client Project Name:** Hookston ANG

Purchase Order #:

Analysis Requested: CENSUS (final), Chain of Custody

Comments:

All samples within this data package were analyzed under U.S. EPA Good Laboratory Practice Standards: Toxic Substances Control Act (40 CFR part 790). All samples were processed according to standard operating procedures. Test results submitted in this data package meet the quality assurance requirements established by Microbial Insights, Inc.

Reported By: Dora M Ogles

Reviewed By: Greg A. Davis

MICROBIAL INSIGHTS, INC.

2340 Stock Creek Blvd. Rockford, TN 37853-3044
Tel: (865) 573-8188; Fax: (865) 573-8133

Q Potential (DNA)

Client:	**Terra Systems, Inc.**	**MI Project Number:**	**031DD**
Project:	Hookston ANG	Date Received:	04/19/2006

Sample Information

Client Sample ID:		**A**	**B**
Sample Date:		04/18/2006	04/18/2006
Units:		cells/g	cells/g
Dechlorinating Bacteria			
Dehalococcoides spp (1)	DHC	**1.68E+03**	**6.34E+03**
Functional Genes			
TCE R-Dase (1)	TCE	<9.47E+02	**4.43E+00 (J)**
VC R-Dase	VCR	<9.47E+02	**9.03E+02 (J)**

Legend:

NA = Not Analyzed NS = Not Sampled J = Estimated gene copies below PQL but above LQL I = Inhibited
< = Result not detected

Notes:

1 Bio-Dechlor Census technology was developed by Dr. Loeffler and colleagues at Georgia Institute of Technology and was licensed for use through Regenesis.

REPORT TO:

Reports will be provided to the contact(s) listed below. Parties other than the contact(s) listed below will require prior approval.

Name: Mike Lee
Company: TerraSystems Inc
Address: 1035 Philadelphia Pike
Suite E
Wilmington DE 19809
email: mlee@terrasystems.net
Phone: (302) 798 9553
Fax: (302) 798 9554

Project Manager: Mike Lee
Project Name: Hookston ANG
Project No.:

INVOICE TO:

For Invoices **paid by a third party** it is imperative that contact information & corresponding reference No. be provided.

Name: Same
Company:
Address:

email:
Phone: ( )
Fax: ( )

Purchase Order No.
Subcontract No.

microbialinsights

2340 Stock Creek Blvd.
Rockford, TN 37853-3044
phone (865) 573-8188
fax: (865) 573-8133
email: info@microbe.com
www.microbe.com

Please Check One:
- [ ] More Samples to Follow
- [x] No Additional Samples

Please contact us prior to submitting samples regarding questions about the analyses you are requesting at (865) 573-8188 (8:00 am to 5:00 pm M-F). After these hours please call (865) 300-8053.

MI ID (Laboratory Use Only)	Sample Name	Date Sampled	Matrix	Contaminant (BTEX, TCE, etc.)	PLFA	VFA	M/E/E	DGGE-16S	DGGE+SEQ	qEBAC (Total)	qSRB/IRB	qMGN (methanogens)	qMOB (methanotrophs)	qDNF (Denitrifying)	qAOB (ammonia oxidizing)	qDHC (Dehalococcoides)	qTCE R-Dase	qBAV1 VC R-Dase generic VC-R	qDHB (Dehalobacter)	qDSM (Desulfuromonas)	qPM1 (MTBE aerobic)	qTOD (Initial PAHs aerobic)	qCAT (Intermediate PAHs aerobic)	qBSS (Toluen/Xylene Anaerobic)	qNAH (Napthalene aerobic)	etc. qPCR	Other:	Other:	Other:
031DD 1	A	4/18/06	S	TCE												+	X	+											
2	B	4/18/06	S	TCE												X	X	X											

Relinquished by: Michael Lee Date: 4/18/06 16:25 Received by:

In order for analysis to be completed correctly, it is vital that chain of custody is filled out correctly & that all relative information is provided. Failure to [...] information may result in delays for which MI will not be liable.

Sample(s) Received: 04.19.06 FedEx Time: 1010

COC sent: Y N Bottle ID match: Y N 2 Oak Ridge tubes of soil

Temp.: 17°C All intact? ✓

No. of damaged/missing samples: —

Sample Analyses Requested

CUL DNA IAQ PLFA VFA Other:

Set #: 031DD Signed:

Appendix E
Soil Vapor Extraction Pilot Test

APPENDIX E – SOIL VAPOR EXTRACTION PILOT TEST

LIST OF FIGURES

LIST OF ATTACHMENTS

1.0 INTRODUCTION

On behalf of Union Pacific Railroad Company and Daniel C. Helix (on behalf of himself, Mary Lou Helix, Elizabeth Young, John V. Hook, Steven Pucell, Nancy Ellicock, and the Contra Costa Redevelopment Agency), ERM-West, Inc. (ERM) has prepared this *Soil Vapor Extraction Pilot Study Summary Report* for the Hookston Station site in Pleasant Hill, California (the "site"). In order to evaluate soil vapor extraction (SVE) as a potential remedial alternative for the site, a pilot test was conducted on 11 April 2006.

SVE involves the application of a vacuum to wells screened in the unsaturated zone of contaminated soils. The vacuum, which is applied using an aboveground blower, induces vapor flow through impacted soils. The volatile organic compounds (VOCs) within the soil are removed through evaporation, volatilization, and desorption through the extraction wells. The extracted vapors are typically treated with granular activated carbon or with a thermal or catalytic oxidizer prior to discharge to the atmosphere.

The pilot test focused on obtaining the following system design parameters:

- A vapor flow rate system curve (vacuum versus vapor flow curve);
- Air permeability of unsaturated soils;
- Vacuum influence, radius of influence (ROI) and directional variations of the extraction well;
- Chemical constituents and concentrations in extracted soil vapor;
- Mass removal rates; and
- Water generation rates.

1.1 PILOT STUDY LOCATION

In order to maximize mass removal rates, demonstrate the capabilities of soil vapor extraction (SVE) as a remediation alternative, and to simulate system design conditions, the pilot study wells were located along the groundwater plume source area where the subsurface conditions were thought to be fairly representative of the site as a whole (Figure E-1). This location also allows for accurate mass removal estimations for the design of vapor abatement equipment, as well as allowing for eventual scale up of the SVE system. To facilitate implementation of the SVE pilot study, one extraction well and three monitoring wells were installed. Well locations are shown on Figure E-1. Boring logs for the wells are provided in Attachment A. A detailed discussion of the activities completed during the installation of the SVE wells is provided in the following subsection.

1.2 SVE WELL INSTALLATION

One SVE well (SVE-1) and three test wells (TW-2, TW-3, and TW-4) were installed as a part of the SVE pilot test (Figure E-1). Prior to installing the wells, the following activities were completed:

- A well installation permit was obtained from the Contra Costa County Environmental Health Department;
- Underground Service Alert was notified; and
- ForeSite Engineering Services, a private utility locating service, was retained to clear the drilling location.

Gregg Drilling and Testing, Inc., a drilling subcontractor from Martinez, California, was retained to perform the well installations. A hollow-stem auger drill rig was used to conduct the drilling, sampling, and well installation activities on 7 and 10 April 2006. The drilling locations were hand-cleared to 5 feet below ground surface (bgs) to minimize the potential for encountering underground utilities during drilling activities.

Monitoring well SVE-1 was advanced to a total depth of 12 feet bgs and wells TW-2 through TW-4 were advanced to a total depth of 25 feet bgs with 6-inch diameter hollow stem augers.

Soil samples were collected continuously using 18- and 24-inch California-modified split spoon samplers. Boring logs, prepared in the field by ERM geologists using the Unified Soil Classification System, are included in Attachment A. The geologist recorded vertical changes in soil lithology, color, moisture content, grain size, and texture, as well as any observations of staining or odors.

Soil samples were collected for geotechnical analysis from the unsaturated zone and the A-Zone aquifer at each well location. The samples were collected in shelby tubes, labeled, and sent under proper chain-of-custody procedure to Cooper Testing Labs in Palo Alto, California, for the following analysis:

- Grain size distribution (American Society for Testing and Materials [ASTM] D422);
- Dry bulk density, total porosity, effective porosity, air-filled porosity, water-filled porosity, and moisture content (API RP40 and ASTM D2325m);
- Specific gravity (ASTM D854m);
- Percent saturation (ASTM D5084); and
- Total organic content (Walkley-Black).

Once the total depth of the boring was reached and the samples were collected, the boring was then over-drilled with using 10-inch (SVE-1) or 8-inch (TW-2 through TW-4) diameter hollow stem augers in order to accommodate the installation of the well materials. SVE-1 was then constructed with 4-inch-diameter polyvinyl chloride screen (0.020-inch machine-slotted) from 5 to 12 feet bgs and blank riser pipe to the ground surface. Wells TW-2 through TW-4 were constructed with 2-inch diameter polyvinyl chloride screen (0.020-inch machine-slotted) from 5 to 25 feet bgs and blank riser pipe to the ground surface. For each well, a filter pack of #2/12 sand was placed within the annular space to approximately 6 inches above the top of the screen interval. The transition seal consisted of 2 feet of bentonite chips hydrated with potable water approximately 30 minutes prior to placement of the cement-bentonite seal. SVE-1 and TW-2 through TW-4 were completed at the ground surface with a flush-mounted well vault, watertight expansion cap, and secured with a lock.

Wells TW-2 through TW-4 were developed on 13 April 2006 using a dedicated disposable bailer for each well. Approximately 18 gallons (roughly 10 well volumes) were removed from each well. The wells were also surged during development to remove any sediment that entered during installation. Stabilization parameters (acidity/alkalinity, specific conductance, turbidity, and temperature) were monitored and recorded during development. Copies of the well logs are provided in Attachment A and the geotechnical analytical results are included in Appendix F of the Feasibility Study.

1.3 SOIL VAPOR EXTRACTION PILOT TEST EQUIPMENT

The SVE pilot test equipment consisted of a generator, a vacuum blower, a liquid knockout vessel, a liquid transfer pump, a thermal oxidizer, a recovered-liquids containment tank, and conveyance piping. The generator, vacuum blower, knockout vessel, and transfer pump were installed on a trailer. Vapor effluent from the blower was routed through the thermal oxidizer for treatment prior to discharge to the atmosphere. Other equipment used for the pilot test included a thermal anemometer, vacuum gauges, a vacuum pump, and a photoionization detector.

2.0 PILOT TEST PROCEEDURES

The purpose of the pilot test was to obtain the design parameters that are necessary for evaluating SVE as a remedial alternative for the site. Two field tests were conducted to collect the SVE design data. The first was a step test designed to measure the vapor flow versus vacuum applied to the extraction well. Following the step test, a short-term pilot test was conducted to determine the soil air permeability, ROI, extracted vapor concentrations, and mass removal rates. Prior to the start of the pilot test, the Bay Area Air Quality Monitoring Board was notified as per Regulation 8 Rule 47 specifications.

2.1 INITIAL WELL MEASUREMENTS

Prior to startup of the pilot tests, baseline measurements of groundwater elevations, wellhead VOC readings, and wellhead vacuum readings were collected under static conditions from the test wells. These measurements are included in Attachment B.

2.2 SYSTEM PERFORMANCE STEP TEST

Following collection of the baseline data, the SVE system was started. A system performance step test was conducted to collect data on flow rate versus applied vacuum.

The test began with the air dilution valve at the blower completely open. The dilution valve was then closed to achieve an initial vacuum of 10 inches of water (in H_2O). The resulting vapor flow rate was allowed to stabilize, measured with a hot-wire anemometer, and recorded. This procedure was repeated in seven increments of increasing vacuum until the valve had been sufficiently closed to achieve the maximum operating vacuum of the pump (roughly 340 in H_2O). The readings collected during the step test are presented in Attachment B.

The flow rate versus applied vacuum data was plotted and this data was used to determine the most efficient operating vacuum for the system. Based on this data, it was determined that the maximum flow rate occurred when a vacuum of roughly 100 in H_2O was applied to the extraction well. As a result, further testing of the SVE system was conducted while operating at an applied vacuum of about 100 in H_2O.

2.3 *SHORT-TERM PILOT TEST*

Once the SVE system step test was completed, the SVE system was shut down to allow the area to return to baseline conditions. Data loggers designed to continuously measure and record air pressure were placed in the monitoring wells (TW-2, TW-3, and TW-4). In addition, specialized well caps were fitted to the test wells to allow for collection of manual pressure readings.

Once all equipment was in place, the SVE system was started and operated at an initial vacuum of 100 in H_2O. The vacuum was adjusted throughout the test to attempt to maintain a constant flow rate of approximately 145 standard cubic feet per minute (scfm). Since the first few minutes of the pilot test are critical for data collection, as the rate of change is usually greatest during this period, extraction well vacuum readings, photoionization detector readings, extracted vapor flow rate, and induced vacuum readings at the monitoring wells were collected as quickly as possible for the first 30 minutes and every 10 minutes for the next 40 minutes. After 10 and 20 minutes, vapor samples were collected for laboratory analysis. Subsequent readings were generally collected every 30 minutes over the remaining duration of the 6-hour test. Prior to completion of the test, final readings were recorded and a third vapor sample was collected for laboratory analysis. The field data is provided in Attachment B.

The three extracted vapor samples collected for laboratory analysis were submitted to Air Toxics, Ltd., in Folsom, California, for analysis of chlorinated VOCs using United States Environmental Protection Agency Method TO-14. The laboratory analytical results are provided in Attachment C.

3.0 DATA EVALUATION AND RESULTS

This section provides a summary of the data obtained, observations made and evaluations conducted as they relate to designing a technically and economically feasible full-scale SVE system. The field data logs, analytical data, and calculations are provided in Attachments B, C, and D, respectively.

3.1 SYSTEM PERFORMANCE STEP TESTING

Figure E-2 presents a vacuum versus flow performance curve for the site. A maximum flow rate of approximately 154 scfm was observed at a vacuum of 100 in H_2O. The flow rate decreased as the applied vacuum to the extraction well increased beyond 100 in H_2O. This decrease in flow at increasing vacuum is likely due to a reduction in unsaturated media available for vapor flow caused by groundwater mounding. The most efficient operating conditions of the SVE system occurred while applying a vacuum of about 100 in H_2O.

3.2 PERMEABILITY TESTING

The soil permeability with respect to air was calculated under transient conditions and using a steady state approach. Under transient conditions, the Cooper-Jacob approximation of the Johnson, Kemblowski, and Colthart (United States Army Corps of Engineers [USACE] 2002) solution for transient radial two-dimensional flow was used to calculate the soil air permeability. Vacuum measurements from each monitoring well were plotted with respect to time on a log scale (Figure E-3). A linear fit was applied to each plot and the slope of this line was used to calculate the soil air permeability. These calculations are included in Attachment D-2.

Using this approach, the following soil air permeabilities were calculated:

K_{TW-2} = 201 darcy

K_{TW-3} = 57 darcy

K_{TW-4} = 304 darcy

The soil air permeability was also calculated based on an equation for one-dimensional radial flow (USACE 2002). With this method, the soil air permeability is calculated using the vacuum measurements from monitoring points at varying distances from the extraction well after the system has reached a steady state. These calculations are included in Attachment D-3. Using this steady state approach, the following soil air permeabilities were calculated:

$K_{TW-2/TW-3}$ = 62 darcy

$K_{TW-3/TW-4}$ = 27 darcy

The soil air permeability values calculated using the steady state approach were very similar to the value calculated for TW-3 under transient conditions. For the purpose of this evaluation, it was assumed that these values most accurately represent the average soil air permeability at the site. As a result, the value for soil air permeability that is assumed to be representative of the site is estimated at 60 darcy.

3.3 VACUUM INFLUENCE AND RADIUS OF INFLUENCE

Figure E-4 shows the relationship between the vacuums observed in the monitoring wells versus their distance from the extraction well. As shown in this figure, the observed vacuum influence was greater in TW-2, located approximately 20 feet from the extraction well, than in TW-4, which is located approximately 10 feet from the extraction well. This indicates that vacuum influence is not radial and that the actual vacuum influence for a SVE well would likely vary due to heterogeneity of soils across the site.

The system ROI was calculated using the steady state equation for one-dimensional radial flow (USACE 2002). Using the values observed during the test at TW-3, the radial distance from the extraction well that would produce a vacuum measurement of 0.01 in H_2O was calculated to be roughly 26 feet. ROI calculations are provided in Attachment D.

The USACE recommends that minimum pore gas velocity of 3 to 30 feet per day be used for the design criteria when determining the ROI. Using darcy's law, it was determined that the pore gas velocity at a radial distance of 26 feet under a vacuum of 0.01 in H_2O was 15 feet per day, which falls within the USACE guidelines (Attachment D).

3.4 *EXTRACTED VAPOR CONCENTRATIONS*

Three vapor samples were collected and submitted for laboratory analysis during the pilot test. Although several VOCs were detected in the samples, the primary constituents of concern were 1,1-dicloroethene (DCE), *cis*-1,2-DCE, trichloroethene (TCE), and tetrachloroethene (PCE). The vapor sampling showed:

- Total VOC concentrations ranging from 9.1 to 77.6 micrograms per liter (ug/L);
- 1,1-DCE concentrations ranging from 0.10 to 0.95 ug/L;
- *cis*-1,2-DCE concentrations ranging from 0.034 to 0.32 ug/L;
- TCE concentrations ranging from 8.9 to 76.0 ug/L; and
- PCE concentrations ranging from 0.048 to 0.37 ug/L.

These data show increasing VOC concentrations over the duration of the pilot test, with final concentrations over 8 times greater than the initial readings. Analytical results are provided in Attachment C.

3.5 *MASS REMOVAL RATES*

Based on the concentrations and extracted flow rates observed, the mass removal rates for the pilot test ranged from 0.12 to 1.01 pounds per day (lbs/day), with TCE accounting for over 97 percent of the total. Over the duration of the 6-hour test, <0.01 lbs of 1,1-DCE, <0.01 lbs or *cis*-1,2-DCE, 0.13 lbs of TCE, and <0.01 lbs of PCE were extracted from the subsurface. Mass removal calculations are presented in Attachment D-5.

3.6 *WATER GENERATION RATES*

Measurable amounts of water were not observed during the SVE pilot study. It is likely that long-term operation, especially during winter months, could produce condensation, but water generation is anticipated to be minimal.

4.0 CONCLUSIONS

This section provides the conclusions developed as part of the SVE pilot test:

- The optimal vacuum for SVE operation was determined to be 100 in H_20.
- Substantial vapor flow (150 scfm) can be achieved from a shallow extraction well with a short well screen (7 feet);
- Groundwater mounding in the extraction well appears to occur at vacuums in excess of 100 in H_20;
- Soil permeabilities are calculated at 60 darcy;
- Vacuum influence and ROI calculations indicate a well spacing of 40 to 50 feet would be appropriate for an effective zone of influence;
- The SVE treatment area may be variable due to lithological heterogeneity of vadoze zone soils and surface covers (i.e., paving);
- The primary extracted contaminant, TCE, accounts for over 97 percent of the material expected to be extracted;
- Mass removal rates of less than 1 lb per day can be expected from the extraction wells; and
- Significant water production is not expected when operating the system at 100 in H_20.

5.0 REFERENCES

United States Army Corps of Engineers. 2002. *Soil Vapor Extraction and Bioventing*. EM 1110-1-4001.

Figures

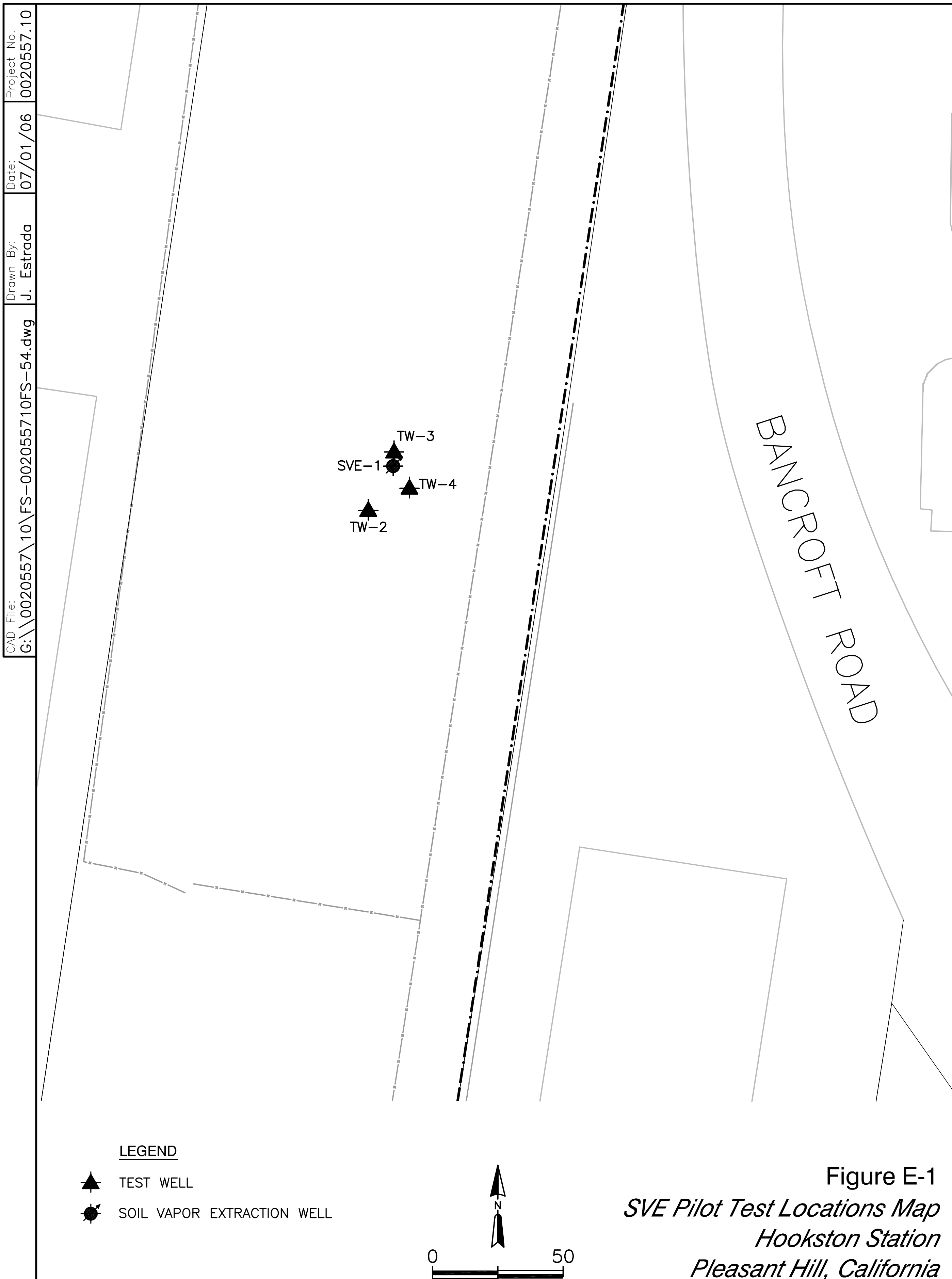


Figure E-1
SVE Pilot Test Locations Map
Hookston Station
Pleasant Hill, California
ERM 07/06

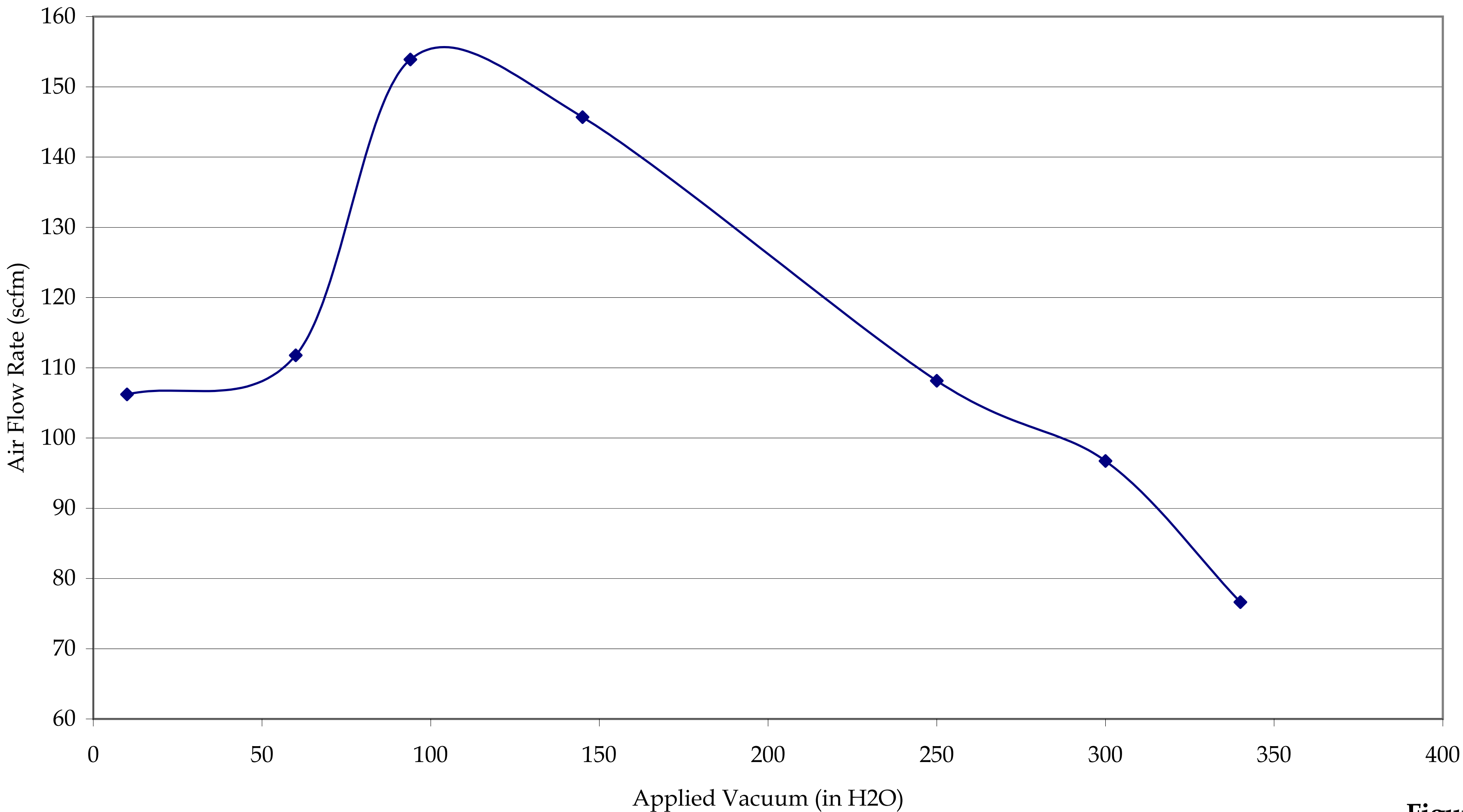


Figure E-2
SVE Performance Test
Vacuum Readings versus Time
Hookston Station
Pleasant Hill, California

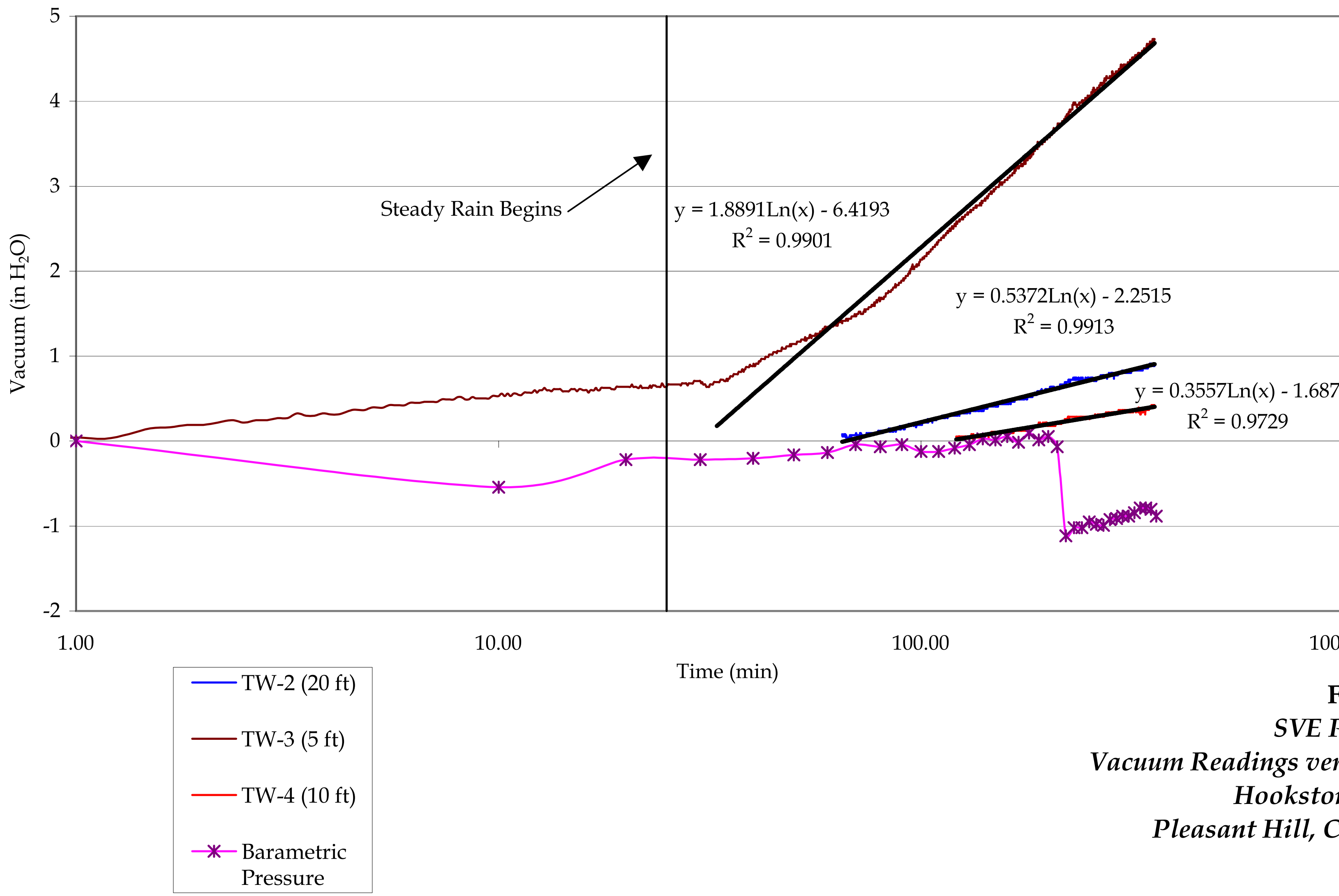


Figure E-3
SVE Pilot Test
Vacuum Readings versus Time
Hookston Station
Pleasant Hill, California

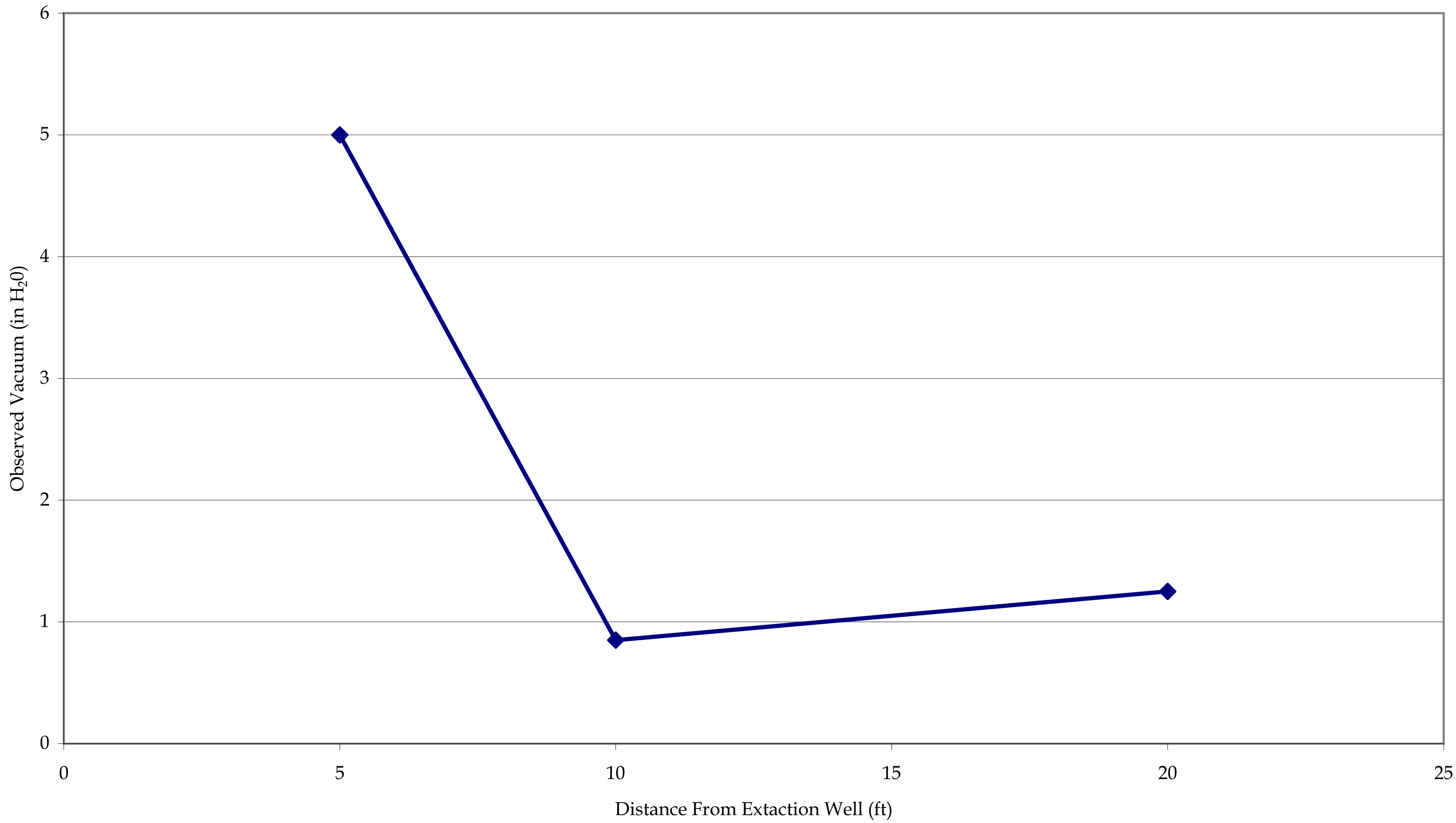


Figure E-4
SVE Pilot Test
Vacuum versus Distance
Hookston Station
Pleasant Hill, California

Attachment A
Well Construction Logs

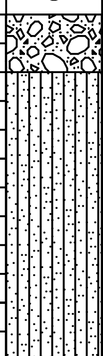
ERM
1777 Botelho Drive
Suite 260
Walnut Creek, California 94596
(925) 946-0455

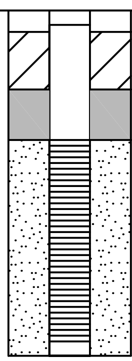
BOREHOLE LOG

Project Number: 0020557.10
Project Name: UP Hookston Station
Location: Pleasant Hill
Contractor: Gregg
Drilling Method: Hollow Stem Auger
Logged By: C. McDonough
Date(s): 04/10/06
Initial Water Level: NA
X-Coordinate: NA
Y-Coordinate: NA

Total Depth: 12.00'
Completed Depth: 12.00'
Borehole Dia.: 8.00in

Blank Casing:				
type: Sch 40 PVC		dia: 2.00in	fm: 0.50'	to: 4.50'
type: Well Cap		dia: 2.00in	fm: 11.50'	to: 12.00'
Screens:				
type: Slotted	size: 0.020in	dia: 2.00in	fm: 4.50'	to: 11.50'
Annular Fill:				
type: Grout			fm: 0.75'	to: 2.50'
type: Bentonite			fm: 2.50'	to: 4.50'
type: #2/12 Sand Filter			fm: 4.50'	to: 12.00'





Depth (ft)	Graphic Log	USCS Code	Well Construction	Sample Recovery	Blow Count	PID (ppm)	Soil Description and Observations
		FILL				0.0	Hand auger, 0-5.0'. GRAVEL (GM): gray, gravel, 1.0-1.5" in size, some silt, dry (fill).
		SM					SILTY SAND (SM): dark brown, fine grained sand, cohesive, dense, dry.
5						0.0	
						0.0	SILTY SAND (SM): as above.
10						0.0	SILTY SAND (SM): as above.
							Total Depth - 12.0' bgs
15							
20							
25							
30							
35							

ERM
1777 Botelho Drive
Suite 260
Walnut Creek, California 94596
(925) 946-0455

BOREHOLE LOG

Project Number: 0020557.10
Project Name: UP Hookston Station
Location: Pleasant Hill
Contractor: Gregg
Drilling Method: Hollow Stem Auger
Logged By: C. McDonough
Date(s): 04/07/06
Initial Water Level: 18.00'
X-Coordinate: NA
Y-Coordinate: NA

Total Depth: 25.00'
Completed Depth: 25.00'
Borehole Dia.: 8.00in

Blank Casing:				
type: Sch 40 PVC		dia: 2.00in	fm: 0.50'	to: 4.50'
type: Well Cap		dia: 2.00in	fm: 24.50'	to: 25.00'

Screens:				
type: Slotted	size: 0.020in	dia: 2.00in	fm: 4.50'	to: 24.50'

Annular Fill:		
type: Grout	fm: 0.75'	to: 2.50'
type: Bentonite	fm: 2.50'	to: 4.50'
type: #2/12 Sand Filter	fm: 4.50'	to: 25.00'

Depth (ft)	USCS Code	Blow Count	PID (ppm)	Soil Description and Observations
0				Hand auger, 0–5.0'.
	FILL		0.0	SILTY GRAVEL (GM): gray, compacted gravel, 0.5–1.0" in size, some silt and trace sand, dense (fill).
			0.0	
	CL			SILTY CLAY (CL): brown, trace fine sand, low plasticity, crumbly, dry.
5		6 12 18		SILTY CLAY (CL): as above.
		9 12 21		SILTY CLAY (CL): as above, light brown.
		7 12 15		No recovery.
10		7 12 15	0.0	SILTY CLAY (CL): as above, trace cemented grains (loosely cemented grains, 0.5–1.0" in diameter).
				SILTY CLAY (CL): as above.
			0.0	SILTY CLAY (CL): brown, some fine grained sand, medium stiff, medium plasticity, moist.
15				SILTY CLAY (CL): as above.
	▽		0.0	
20	SM			SILTY SAND (SM): brown, some fine to medium grained sand, soft, loose, moist.
25	CL		0.0	CLAY (CL): brown, trace fine grained sand, medium stiff, moist.
				Total Depth – 25.0' bgs

Depth (ft): 5, 10, 15, 20, 25, 30, 35

ERM
1777 Botelho Drive
Suite 260
Walnut Creek, California 94596
(925) 946-0455

BOREHOLE LOG

Project Number: 0020557.10
Project Name: UP Hookston Station
Location: Pleasant Hill
Contractor: Gregg
Drilling Method: Hollow Stem Auger
Logged By: C. McDonough
Date(s): 04/07/06
Initial Water Level: 14.00'
X-Coordinate: NA
Y-Coordinate: NA

Total Depth: 26.00'
Completed Depth: 25.00'
Borehole Dia.: 8.00in

Blank Casing:

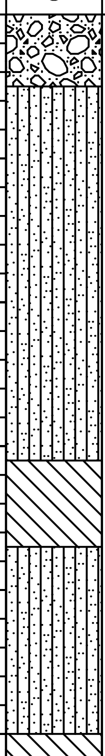
type	size	dia	fm	to
Sch 40 PVC		2.00in	0.50'	4.50'
Well Cap		2.00in	24.50'	25.00'

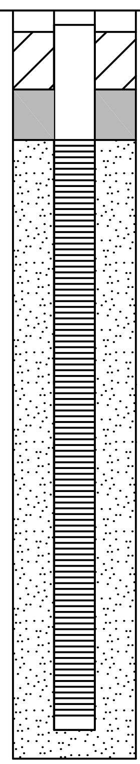
Screens:

type	size	dia	fm	to
Slotted	0.020in	2.00in	4.50'	24.50'

Annular Fill:

type	fm	to
Grout	0.75'	2.50'
Bentonite	2.50'	4.50'
#2/12 Sand Filter	4.50'	26.00'





Depth (ft)	USCS Code	Sample Recovery / Blow Count	PID (ppm)	Soil Description and Observations
0	FILL		0.0	Hand auger, 0–5.0'. GRAVEL (GM): gray, gravel, 0.5–1.0" in size, some silt, trace fine grained sand, dense, compacted (fill).
	SM		0.0	SILTY SAND (SM): brown, trace gravel, 0.25–1.0" in size, slightly cohesive, crumbly, dry.
5				SILTY SAND (SM): dark brown, some fine grained sand, stiff, dense, dry.
		6, 7, 10		SILTY SAND (SM): as above.
10		4, 6, 8	0.0	SILTY SAND (SM): as above.
		5, 7, 11		SILTY SAND (SM): as above.
	⊻		0.0	
15	CL	7, 8, 9	0.0	CLAY (CL): brown, trace fine grained sand and silt, medium plasticity, damp.
	SM	6, 4, 4	0.0	SILTY SAND (SM): brown, fine grained sand, loose, soft, wet.
20		6, 7, 10	0.0	SILTY SAND (SM): as above.
		4, 6, 8		SILTY SAND (SM): as above.
25	CL	5, 7, 11	0.0	CLAY (CL): brown, trace fine grained sand, medium plasticity, stiff, wet. Total Depth – 25.0' bgs
30				
35				

BOREHOLE LOG

ERM
1777 Botelho Drive
Suite 260
Walnut Creek, California 94596
(925) 946-0455

Project Number: 0020557.10
Project Name: UP Hookston Station
Location: Pleasant Hill
Contractor: Gregg
Drilling Method: Hollow Stem Auger
Logged By: C. McDonough
Date(s): 04/10/06
Initial Water Level: 17.50'
X-Coordinate: NA
Y-Coordinate: NA

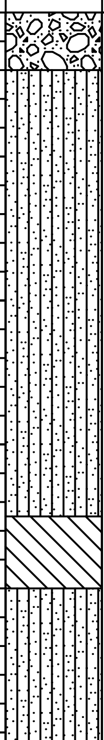
Total Depth: 25.50'
Completed Depth: 25.00'
Borehole Dia.: 8.00in

Blank Casing:				
type: Sch 40 PVC		dia: 2.00in	fm: 0.50'	to: 4.50'
type: Well Cap		dia: 2.00in	fm: 24.50'	to: 25.00'

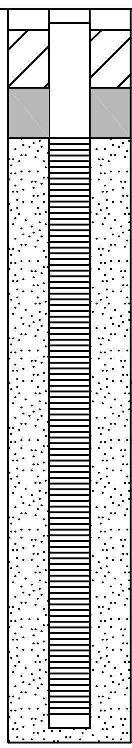
Screens:				
type: Slotted	size: 0.020in	dia: 2.00in	fm: 4.50'	to: 24.50'

Annular Fill:		
type: Grout	fm: 0.75'	to: 2.50'
type: Bentonite	fm: 2.50'	to: 4.50'
type: #2/12 Sand Filter	fm: 4.50'	to: 25.50'

Graphic Log:



Well Construction:



Depth (ft)	USCS Code	Blow Count	PID (ppm)	Soil Description and Observations
0	FILL		0.0	Hand auger, 0–5.0'.
				GRAVEL (GM): gray, gravel, 1.0–1.5" in size, some silt, dense (fill).
	SM			SILTY SAND (SM): dark brown, some fine grained sand, cohesive, stiff, moist.
			0.0	
5				
		5 6 9	0.0	SILTY SAND (SM): dark brown, some fine grained sand, dense, moist.
		3 6 8		SILTY SAND (SM): as above.
10		3 4 5	0.0	SILTY SAND (SM): light brown, some fine grained sand, loose, slightly moist.
			0.0	SILTY SAND (SM): as above, loose.
15				
	∇ CL	2 3 4	0.0	CLAY (CL): brown, trace fine grained sand, soft, medium plasticity, wet.
			0.0	
20	SM	3 3 3		SILTY SAND (SM): light brown, some fine grained sand, loose, damp.
		2 1 2		
		3 3 3	0.0	SILTY SAND (SM): as above, loose.
25		3 6 9		Total Depth – 25.5' bgs
30				
35				

Attachment B
Field Sheets

Environmental Resources Management

1777 Botelho Drive, Suite 260 • Walnut Creek, CA 94596
(925) 946-0455 • Fax (925) 946-9968

Project Hookston Station Project No. ______ Sheet ______ of ______
Subject ______ By ______ Date ______
SVE Pilot Test Field Log Chkd. by ______ Date ______

Monday 4-10-06

11:00 On site to set up SVE system

11:30 Mako On site with SVE skid.
Greg is still working on wells will need to wait for them to leave before we can set up SVE system.

12:30 Greggs Drilling finished installing the extraction well. will not be able to extract from the well today because the grout needs to finish setting

13:00 Set up SVE unit. Fire up generator and blower and Thermal oxidizer.

14:30 All components are working fine. Walk through operating instructions with Mako
* Liquid propane is used for generator and gas for Thermal Oxidizer.

15:30 Arun and Doug on site. Propane Tanks will need to be secured can not leave out over night. Also it is decided that SVE skid needs to be put in a more secure location.

16:00 Arun and Doug off site. Move propane tanks to Fenced in yard ~~owned~~ used by Jack's Auto body

17:00 off site

Environmental Resources Management

1777 Botelho Drive, Suite 260 • Walnut Creek, CA 94596
(925) 946-0455 • Fax (925) 946-9968

Project Hookston Station Project No. ______ Sheet ______ of ______
Subject SVE Pilot Test Field Log By ______ Date ______
Chkd. by ______ Date ______

Tuesday 4-11-06

7:45 On-site, move SVE skid to Pilot location

8:30 Chris on-site with SVE manifold. Set up manifold. Take Baseline Readings

9:30 Starts to lightly rain. Begin system curve testing (see system curve notes)

10:30 Stop system curve test. From system test it is determined that max flow occurs at a vacuum of ~ 100 in H_2O or 7" Hg

11:00 Reset data loggers and place in monitoring wells. Barometric pressure will be recorded on baratroll that Rachel and Chimi are using for pump test.

12:06 Start SVE Pilot Test (see notes)

12:30 Starts to rain steadily. Arun on-site

13:30 Arun off site

15:00 Head to office meet w/ Brian and Arun. Decide SVE Testing will continue until 18:00.

17:00 Back on site

19:00 Finish SVE Testing. Shut down system. disconnect and move to the ~~o~~ corner of the lot.

19:30 off site.

SVE Pilot Test
Soil Vapor Permeability Test
Field Data
Hookston Station

ERM Personnel: KGD CAG Signatures: [signature]
Date and Arrival Time: 4-11-06 9:00
Ambient Temperature: Rainy 60°F

	Time	Extraction Well Readings				Monitoring Well Vacuum Readings (in H_2O)		
		Applied Vacuum in H_2O	Temperature (F)	Flow Velocity (fpm)	Influent PID Reading	TW-2	TW-3	TW-4
	12:07	100 in H_2O	63.6	709	31	NM	NM	NM
	12:10	105	63.4	945	16	Ø	0.5	Ø
	12:13	120	64.2	837	24	NM	NM	NM
10 min	12:16	110	64.5	856	18	0.25	0.5	Ø
	12:20	110	64.3	825	17	0.25	0.5	Ø
20 min	12:26	110	63.8	850	19	0.20	0.55	Ø
	12:36	110	NM	NM	34	0.10	0.6	Ø
	12:46	110	NM	NM	21	0.10	0.6	Ø
	12:56	110	NM	NM	22	~~[illegible]~~ NM	NM	NM
60 min	13:06	110	NM	NM	18	0.15	1.4	0.10
70 min	13:16	110	62.4	996	18	NM	NM	NM
90 min	13:36	110	58.9	945	23	0.25	1.9	0.20
120 min	14:06	105	59.1	1266	19	0.60	3.0	0.40
	15:06	100	59.8	831	22	0.75	3.5	0.50
	15:30	90	58.6	835	28.4	0.80	3.8	0.5
	16:00	90	59.1	845	32	1.0	4.0	0.65
	16:30	90	59.1	822	27	1.0	4.45	0.75
	17:00	90	58.9	823	26.6	1.20	4.6	0.75
	17:30	90	NM	NM	26.2	1.20	4.8	0.80
	18:00	90	NM	NM	21.7	1.25	5.0	0.85

Comments

- Start Time = 12:06
- Thermal anemometer gets wet and stops working @ 12:36
  Chris gets new anemometer @ 13:16
- Tedlar bag samples taken @ 12:16 12:26 and 17:30
- Rain becomes heavy @ ~~about~~ 13:00 lasts for duration
- NM = not measured
- Thermal Oxidizer Stopped Working @ 17:30

SVE Pilot Test
System Perfomance Test
Field Data
Hookston Station

ERM Personnel: RGD GAG
Arrival Time: 8:00
Ambient Temperature: 60°F Rainy

Baseline Readings

Location	Time	DTW	Well head PID	Vac in H2O
Extraction Well				
MW-1 TW-2	9:30	14.51	6.0	∅
MW-2 TW-3	9:30	14.52	6.0	∅
MW-3 TW-4	9:35	14.58	3.0	∅

Performance Test

Step Increment	Time	Applied Vacuum (in Hg)	Temperature (F)	Relative Humidity	Flow Velocity (fpm)	Influent PID Reading	Effluent PID Reading	
1	9:50	10" H2O	63.1	~~553~~ NC	545	6	∅	
2	10:00	60" H2O	66.1	NC	615	3	∅	
3	10:05	94	64.7	NC	890	6	∅	175
4	10:10	145	64.3	NC	920	10	∅	140
5	10:20	9 PSI	64.5	NC	880	20	∅	11
6	10:25	22" Hg	64.2	NC	950	33	NC	
7	10:30	25" Hg	63.7	NC	945	NC	NC	
8								
9								
10								

7" Hg
11" Hg

Comments Operating conditions best @ ≈ 100 in H2O 7" Hg

Attachment C
Soil Vapor Analytical Report

AIR TOXICS LTD.

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Air Toxics Ltd. Introduces the Electronic Report

Thank you for choosing Air Toxics Ltd. To better serve our customers, we are providing your report by e-mail. This document is provided in Portable Document Format which can be viewed with Acrobat Reader by Adobe.

This electronic report includes the following:

- Work order Summary;
- Laboratory Narrative;
- Results; and
- Chain of Custody (copy).

180 BLUE RAVINE ROAD, SUITE B FOLSOM, CA - 95630

(916) 985-1000 .FAX (916) 985-1020
Hours 8:00 A.M to 6:00 P.M. Pacific

AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

WORK ORDER #: 0604225R1

Work Order Summary

CLIENT:	Ms. Kimberly Lake ERM-West 1777 Botelho Drive Suite 260 Walnut Creek, CA 94596	**BILL TO:**	Mr. Alan Nye Center for Toxicology and Environmental Health 615 West Markham Street Little Rock, AR 72201
PHONE:	925-946-0455	**P.O. #**	
FAX:	925-946-9968	**PROJECT #**	20577.10 Hookston Station
DATE RECEIVED:	04/13/2006	**CONTACT:**	Nicole Danbacher
DATE COMPLETED:	04/19/2006		
DATE REISSUED:	04/24/2006		

FRACTION #	**NAME**	**TEST**	**RECEIPT VAC./PRES.**
01A	SVE T1	Modified TO-15	Tedlar Bag
02A	SVE T2	Modified TO-15	Tedlar Bag
03A	SVE T3	Modified TO-15	Tedlar Bag
04A	Lab Blank	Modified TO-15	NA
04B	Lab Blank	Modified TO-15	NA
05A	CCV	Modified TO-15	NA
05B	CCV	Modified TO-15	NA
06A	LCS	Modified TO-15	NA
06B	LCS	Modified TO-15	NA

CERTIFIED BY: Linda L. Freeman DATE: 04/26/06

Laboratory Director

Certfication numbers: CA NELAP - 02110CA, LA NELAP/LELAP- AI 30763, NJ NELAP - CA004
NY NELAP - 11291, UT NELAP - 9166389892
Name of Accrediting Agency: NELAP/Florida Department of Health, Scope of Application: Clean Air Act,
Accreditation number: E87680, Effective date: 07/01/05, Expiration date: 06/30/06
Air Toxics Ltd. certifies that the test results contained in this report meet all requirements of the NELAC standards

LABORATORY NARRATIVE
Modified TO-15
ERM-West
Workorder# 0604225R1

Three 1 Liter Tedlar Bag samples were received on April 13, 2006. The laboratory performed analysis via modified EPA Method TO-15 using GC/MS in the full scan mode. The method involves concentrating up to 0.2 liters of air. The concentrated aliquot is then flash vaporized and swept through a water management system to remove water vapor. Following dehumidification, the sample passes directly into the GC/MS for analysis.

Method modifications taken to run these samples are summarized in the below table. Specific project requirements may over-ride the ATL modifications.

Requirement	*TO-15*	*ATL Modifications*
Daily CCV	+- 30% Difference	</= 30% Difference with two allowed out up to </=40%.; flag and narrate outliers
Sample collection media	Summa canister	ATL recommends use of summa canisters to insure data defensibility, but will report results from Tedlar bags at client request
Method Detection Limit	Follow 40CFR Pt.136 App. B	The MDL met all relevant requirements in Method TO-15 (statistical MDL less than the LOQ). The concentration of the spiked replicate may have exceeded 10X the calculated MDL in some cases

Receiving Notes

There were no receiving discrepancies.

Analytical Notes

The reported LCS for each daily batch has been derived from more than one analytical file.

THE WORKORDER WAS REISSUED ON 4/25/06 TO REPORT RESULTS IN PPBV AS WELL AS UG/M3.

Definition of Data Qualifying Flags

Eight qualifiers may have been used on the data analysis sheets and indicates as follows:

B - Compound present in laboratory blank greater than reporting limit (background subtraction no performed).

J - Estimated value.

E - Exceeds instrument calibration range.

S - Saturated peak.

Q - Exceeds quality control limits.

U - Compound analyzed for but not detected above the reporting limit.

UJ- Non-detected compound associated with low bias in the CCV

N - The identification is based on presumptive evidence.

File extensions may have been used on the data analysis sheets and indicates as follows:

a-File was requantified

b-File was quantified by a second column and detector

r1-File was requantified for the purpose of reissue

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Summary of Detected Compounds
MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

Client Sample ID: SVE T1

Lab ID#: 0604225R1-01A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Ethanol	20	57	38	110
1,1-Dichloroethene	5.0	26	20	100
Acetone	20	24	48	57
2-Butanone (Methyl Ethyl Ketone)	5.0	5.7	15	17
cis-1,2-Dichloroethene	5.0	8.5	20	34
Tetrahydrofuran	5.0	22	15	64
Trichloroethene	5.0	1600	27	8900
Tetrachloroethene	5.0	7.1	34	48
1,4-Dichlorobenzene	5.0	6.4	30	39

Client Sample ID: SVE T2

Lab ID#: 0604225R1-02A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
1,1-Dichloroethene	20	140	79	540
cis-1,2-Dichloroethene	20	39	79	150
Tetrahydrofuran	20	56	59	160
Trichloroethene	20	7300	110	39000
Tetrachloroethene	20	26	140	180

Client Sample ID: SVE T3

Lab ID#: 0604225R1-03A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
1,1-Dichloroethene	50	240	200	950
cis-1,2-Dichloroethene	50	81	200	320
Trichloroethene	50	14000	270	76000
Tetrachloroethene	50	54	340	370

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Client Sample ID: SVE T1

Lab ID#: 0604225R1-01A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**1041407**	**Date of Collection: 4/11/06**
Dil. Factor:	**10.0**	**Date of Analysis: 4/14/06 02:46 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Freon 12	5.0	Not Detected	25	Not Detected
Freon 114	5.0	Not Detected	35	Not Detected
Chloromethane	20	Not Detected	41	Not Detected
Vinyl Chloride	5.0	Not Detected	13	Not Detected
1,3-Butadiene	5.0	Not Detected	11	Not Detected
Bromomethane	5.0	Not Detected	19	Not Detected
Chloroethane	5.0	Not Detected	13	Not Detected
Freon 11	5.0	Not Detected	28	Not Detected
Ethanol	20	57	38	110
Freon 113	5.0	Not Detected	38	Not Detected
1,1-Dichloroethene	5.0	26	20	100
Acetone	20	24	48	57
2-Propanol	20	Not Detected	49	Not Detected
Carbon Disulfide	5.0	Not Detected	16	Not Detected
3-Chloropropene	20	Not Detected	63	Not Detected
Methylene Chloride	5.0	Not Detected	17	Not Detected
Methyl tert-butyl ether	5.0	Not Detected	18	Not Detected
trans-1,2-Dichloroethene	5.0	Not Detected	20	Not Detected
Hexane	5.0	Not Detected	18	Not Detected
1,1-Dichloroethane	5.0	Not Detected	20	Not Detected
2-Butanone (Methyl Ethyl Ketone)	5.0	5.7	15	17
cis-1,2-Dichloroethene	5.0	8.5	20	34
Tetrahydrofuran	5.0	22	15	64
Chloroform	5.0	Not Detected	24	Not Detected
1,1,1-Trichloroethane	5.0	Not Detected	27	Not Detected
Cyclohexane	5.0	Not Detected	17	Not Detected
Carbon Tetrachloride	5.0	Not Detected	31	Not Detected
2,2,4-Trimethylpentane	5.0	Not Detected	23	Not Detected
Benzene	5.0	Not Detected	16	Not Detected
1,2-Dichloroethane	5.0	Not Detected	20	Not Detected
Heptane	5.0	Not Detected	20	Not Detected
Trichloroethene	5.0	1600	27	8900
1,2-Dichloropropane	5.0	Not Detected	23	Not Detected
1,4-Dioxane	20	Not Detected	72	Not Detected
Bromodichloromethane	5.0	Not Detected	34	Not Detected
cis-1,3-Dichloropropene	5.0	Not Detected	23	Not Detected
4-Methyl-2-pentanone	5.0	Not Detected	20	Not Detected
Toluene	5.0	Not Detected	19	Not Detected
trans-1,3-Dichloropropene	5.0	Not Detected	23	Not Detected
1,1,2-Trichloroethane	5.0	Not Detected	27	Not Detected

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Client Sample ID: SVE T1

Lab ID#: 0604225R1-01A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**1041407**	**Date of Collection: 4/11/06**
Dil. Factor:	**10.0**	**Date of Analysis: 4/14/06 02:46 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Tetrachloroethene	5.0	7.1	34	48
2-Hexanone	20	Not Detected	82	Not Detected
Dibromochloromethane	5.0	Not Detected	42	Not Detected
1,2-Dibromoethane (EDB)	5.0	Not Detected	38	Not Detected
Chlorobenzene	5.0	Not Detected	23	Not Detected
Ethyl Benzene	5.0	Not Detected	22	Not Detected
m,p-Xylene	5.0	Not Detected	22	Not Detected
o-Xylene	5.0	Not Detected	22	Not Detected
Styrene	5.0	Not Detected	21	Not Detected
Bromoform	5.0	Not Detected	52	Not Detected
Cumene	5.0	Not Detected	24	Not Detected
1,1,2,2-Tetrachloroethane	5.0	Not Detected	34	Not Detected
Propylbenzene	5.0	Not Detected	24	Not Detected
4-Ethyltoluene	5.0	Not Detected	24	Not Detected
1,3,5-Trimethylbenzene	5.0	Not Detected	24	Not Detected
1,2,4-Trimethylbenzene	5.0	Not Detected	24	Not Detected
1,3-Dichlorobenzene	5.0	Not Detected	30	Not Detected
1,4-Dichlorobenzene	5.0	6.4	30	39
alpha-Chlorotoluene	5.0	Not Detected	26	Not Detected
1,2-Dichlorobenzene	5.0	Not Detected	30	Not Detected
1,2,4-Trichlorobenzene	20	Not Detected	150	Not Detected
Hexachlorobutadiene	20	Not Detected	210	Not Detected

Container Type: 1 Liter Tedlar Bag

Surrogates	%Recovery	Method Limits
Toluene-d8	102	70-130
1,2-Dichloroethane-d4	96	70-130
4-Bromofluorobenzene	94	70-130

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AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: SVE T2

Lab ID#: 0604225R1-02A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**1041318**	**Date of Collection: 4/11/06**
Dil. Factor:	**40.0**	**Date of Analysis: 4/14/06 09:56 AM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Freon 12	20	Not Detected	99	Not Detected
Freon 114	20	Not Detected	140	Not Detected
Chloromethane	80	Not Detected	160	Not Detected
Vinyl Chloride	20	Not Detected	51	Not Detected
1,3-Butadiene	20	Not Detected	44	Not Detected
Bromomethane	20	Not Detected	78	Not Detected
Chloroethane	20	Not Detected	53	Not Detected
Freon 11	20	Not Detected	110	Not Detected
Ethanol	80	Not Detected	150	Not Detected
Freon 113	20	Not Detected	150	Not Detected
1,1-Dichloroethene	20	140	79	540
Acetone	80	Not Detected	190	Not Detected
2-Propanol	80	Not Detected	200	Not Detected
Carbon Disulfide	20	Not Detected	62	Not Detected
3-Chloropropene	80	Not Detected	250	Not Detected
Methylene Chloride	20	Not Detected	69	Not Detected
Methyl tert-butyl ether	20	Not Detected	72	Not Detected
trans-1,2-Dichloroethene	20	Not Detected	79	Not Detected
Hexane	20	Not Detected	70	Not Detected
1,1-Dichloroethane	20	Not Detected	81	Not Detected
2-Butanone (Methyl Ethyl Ketone)	20	Not Detected	59	Not Detected
cis-1,2-Dichloroethene	20	39	79	150
Tetrahydrofuran	20	56	59	160
Chloroform	20	Not Detected	98	Not Detected
1,1,1-Trichloroethane	20	Not Detected	110	Not Detected
Cyclohexane	20	Not Detected	69	Not Detected
Carbon Tetrachloride	20	Not Detected	120	Not Detected
2,2,4-Trimethylpentane	20	Not Detected	93	Not Detected
Benzene	20	Not Detected	64	Not Detected
1,2-Dichloroethane	20	Not Detected	81	Not Detected
Heptane	20	Not Detected	82	Not Detected
Trichloroethene	20	7300	110	39000
1,2-Dichloropropane	20	Not Detected	92	Not Detected
1,4-Dioxane	80	Not Detected	290	Not Detected
Bromodichloromethane	20	Not Detected	130	Not Detected
cis-1,3-Dichloropropene	20	Not Detected	91	Not Detected
4-Methyl-2-pentanone	20	Not Detected	82	Not Detected
Toluene	20	Not Detected	75	Not Detected
trans-1,3-Dichloropropene	20	Not Detected	91	Not Detected
1,1,2-Trichloroethane	20	Not Detected	110	Not Detected

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AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: SVE T2

Lab ID#: 0604225R1-02A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**1041318**	**Date of Collection:**	**4/11/06**
Dil. Factor:	**40.0**	**Date of Analysis:**	**4/14/06 09:56 AM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Tetrachloroethene	20	26	140	180
2-Hexanone	80	Not Detected	330	Not Detected
Dibromochloromethane	20	Not Detected	170	Not Detected
1,2-Dibromoethane (EDB)	20	Not Detected	150	Not Detected
Chlorobenzene	20	Not Detected	92	Not Detected
Ethyl Benzene	20	Not Detected	87	Not Detected
m,p-Xylene	20	Not Detected	87	Not Detected
o-Xylene	20	Not Detected	87	Not Detected
Styrene	20	Not Detected	85	Not Detected
Bromoform	20	Not Detected	210	Not Detected
Cumene	20	Not Detected	98	Not Detected
1,1,2,2-Tetrachloroethane	20	Not Detected	140	Not Detected
Propylbenzene	20	Not Detected	98	Not Detected
4-Ethyltoluene	20	Not Detected	98	Not Detected
1,3,5-Trimethylbenzene	20	Not Detected	98	Not Detected
1,2,4-Trimethylbenzene	20	Not Detected	98	Not Detected
1,3-Dichlorobenzene	20	Not Detected	120	Not Detected
1,4-Dichlorobenzene	20	Not Detected	120	Not Detected
alpha-Chlorotoluene	20	Not Detected	100	Not Detected
1,2-Dichlorobenzene	20	Not Detected	120	Not Detected
1,2,4-Trichlorobenzene	80	Not Detected	590	Not Detected
Hexachlorobutadiene	80	Not Detected	850	Not Detected

Container Type: 1 Liter Tedlar Bag

Surrogates	%Recovery	Method Limits
Toluene-d8	100	70-130
1,2-Dichloroethane-d4	96	70-130
4-Bromofluorobenzene	91	70-130

@ **AIR TOXICS LTD.**

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: SVE T3

Lab ID#: 0604225R1-03A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**1041408**	**Date of Collection: 4/11/06**
Dil. Factor:	**100**	**Date of Analysis: 4/14/06 03:26 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Freon 12	50	Not Detected	250	Not Detected
Freon 114	50	Not Detected	350	Not Detected
Chloromethane	200	Not Detected	410	Not Detected
Vinyl Chloride	50	Not Detected	130	Not Detected
1,3-Butadiene	50	Not Detected	110	Not Detected
Bromomethane	50	Not Detected	190	Not Detected
Chloroethane	50	Not Detected	130	Not Detected
Freon 11	50	Not Detected	280	Not Detected
Ethanol	200	Not Detected	380	Not Detected
Freon 113	50	Not Detected	380	Not Detected
1,1-Dichloroethene	50	240	200	950
Acetone	200	Not Detected	480	Not Detected
2-Propanol	200	Not Detected	490	Not Detected
Carbon Disulfide	50	Not Detected	160	Not Detected
3-Chloropropene	200	Not Detected	630	Not Detected
Methylene Chloride	50	Not Detected	170	Not Detected
Methyl tert-butyl ether	50	Not Detected	180	Not Detected
trans-1,2-Dichloroethene	50	Not Detected	200	Not Detected
Hexane	50	Not Detected	180	Not Detected
1,1-Dichloroethane	50	Not Detected	200	Not Detected
2-Butanone (Methyl Ethyl Ketone)	50	Not Detected	150	Not Detected
cis-1,2-Dichloroethene	50	81	200	320
Tetrahydrofuran	50	Not Detected	150	Not Detected
Chloroform	50	Not Detected	240	Not Detected
1,1,1-Trichloroethane	50	Not Detected	270	Not Detected
Cyclohexane	50	Not Detected	170	Not Detected
Carbon Tetrachloride	50	Not Detected	310	Not Detected
2,2,4-Trimethylpentane	50	Not Detected	230	Not Detected
Benzene	50	Not Detected	160	Not Detected
1,2-Dichloroethane	50	Not Detected	200	Not Detected
Heptane	50	Not Detected	200	Not Detected
Trichloroethene	50	14000	270	76000
1,2-Dichloropropane	50	Not Detected	230	Not Detected
1,4-Dioxane	200	Not Detected	720	Not Detected
Bromodichloromethane	50	Not Detected	340	Not Detected
cis-1,3-Dichloropropene	50	Not Detected	230	Not Detected
4-Methyl-2-pentanone	50	Not Detected	200	Not Detected
Toluene	50	Not Detected	190	Not Detected
trans-1,3-Dichloropropene	50	Not Detected	230	Not Detected
1,1,2-Trichloroethane	50	Not Detected	270	Not Detected

AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: SVE T3

Lab ID#: 0604225R1-03A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**1041408**	**Date of Collection: 4/11/06**
Dil. Factor:	**100**	**Date of Analysis: 4/14/06 03:26 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Tetrachloroethene	50	54	340	370
2-Hexanone	200	Not Detected	820	Not Detected
Dibromochloromethane	50	Not Detected	420	Not Detected
1,2-Dibromoethane (EDB)	50	Not Detected	380	Not Detected
Chlorobenzene	50	Not Detected	230	Not Detected
Ethyl Benzene	50	Not Detected	220	Not Detected
m,p-Xylene	50	Not Detected	220	Not Detected
o-Xylene	50	Not Detected	220	Not Detected
Styrene	50	Not Detected	210	Not Detected
Bromoform	50	Not Detected	520	Not Detected
Cumene	50	Not Detected	240	Not Detected
1,1,2,2-Tetrachloroethane	50	Not Detected	340	Not Detected
Propylbenzene	50	Not Detected	240	Not Detected
4-Ethyltoluene	50	Not Detected	240	Not Detected
1,3,5-Trimethylbenzene	50	Not Detected	240	Not Detected
1,2,4-Trimethylbenzene	50	Not Detected	240	Not Detected
1,3-Dichlorobenzene	50	Not Detected	300	Not Detected
1,4-Dichlorobenzene	50	Not Detected	300	Not Detected
alpha-Chlorotoluene	50	Not Detected	260	Not Detected
1,2-Dichlorobenzene	50	Not Detected	300	Not Detected
1,2,4-Trichlorobenzene	200	Not Detected	1500	Not Detected
Hexachlorobutadiene	200	Not Detected	2100	Not Detected

Container Type: 1 Liter Tedlar Bag

Surrogates	%Recovery	Method Limits
Toluene-d8	99	70-130
1,2-Dichloroethane-d4	98	70-130
4-Bromofluorobenzene	100	70-130

AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: Lab Blank

Lab ID#: 0604225R1-04A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**1041307**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 4/13/06 03:36 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Freon 12	0.50	Not Detected	2.5	Not Detected
Freon 114	0.50	Not Detected	3.5	Not Detected
Chloromethane	2.0	Not Detected	4.1	Not Detected
Vinyl Chloride	0.50	Not Detected	1.3	Not Detected
1,3-Butadiene	0.50	Not Detected	1.1	Not Detected
Bromomethane	0.50	Not Detected	1.9	Not Detected
Chloroethane	0.50	Not Detected	1.3	Not Detected
Freon 11	0.50	Not Detected	2.8	Not Detected
Ethanol	2.0	Not Detected	3.8	Not Detected
Freon 113	0.50	Not Detected	3.8	Not Detected
1,1-Dichloroethene	0.50	Not Detected	2.0	Not Detected
Acetone	2.0	Not Detected	4.8	Not Detected
2-Propanol	2.0	Not Detected	4.9	Not Detected
Carbon Disulfide	0.50	Not Detected	1.6	Not Detected
3-Chloropropene	2.0	Not Detected	6.3	Not Detected
Methylene Chloride	0.50	Not Detected	1.7	Not Detected
Methyl tert-butyl ether	0.50	Not Detected	1.8	Not Detected
trans-1,2-Dichloroethene	0.50	Not Detected	2.0	Not Detected
Hexane	0.50	Not Detected	1.8	Not Detected
1,1-Dichloroethane	0.50	Not Detected	2.0	Not Detected
2-Butanone (Methyl Ethyl Ketone)	0.50	Not Detected	1.5	Not Detected
cis-1,2-Dichloroethene	0.50	Not Detected	2.0	Not Detected
Tetrahydrofuran	0.50	Not Detected	1.5	Not Detected
Chloroform	0.50	Not Detected	2.4	Not Detected
1,1,1-Trichloroethane	0.50	Not Detected	2.7	Not Detected
Cyclohexane	0.50	Not Detected	1.7	Not Detected
Carbon Tetrachloride	0.50	Not Detected	3.1	Not Detected
2,2,4-Trimethylpentane	0.50	Not Detected	2.3	Not Detected
Benzene	0.50	Not Detected	1.6	Not Detected
1,2-Dichloroethane	0.50	Not Detected	2.0	Not Detected
Heptane	0.50	Not Detected	2.0	Not Detected
Trichloroethene	0.50	Not Detected	2.7	Not Detected
1,2-Dichloropropane	0.50	Not Detected	2.3	Not Detected
1,4-Dioxane	2.0	Not Detected	7.2	Not Detected
Bromodichloromethane	0.50	Not Detected	3.4	Not Detected
cis-1,3-Dichloropropene	0.50	Not Detected	2.3	Not Detected
4-Methyl-2-pentanone	0.50	Not Detected	2.0	Not Detected
Toluene	0.50	Not Detected	1.9	Not Detected
trans-1,3-Dichloropropene	0.50	Not Detected	2.3	Not Detected
1,1,2-Trichloroethane	0.50	Not Detected	2.7	Not Detected

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AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: Lab Blank

Lab ID#: 0604225R1-04A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**1041307**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 4/13/06 03:36 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Tetrachloroethene	0.50	Not Detected	3.4	Not Detected
2-Hexanone	2.0	Not Detected	8.2	Not Detected
Dibromochloromethane	0.50	Not Detected	4.2	Not Detected
1,2-Dibromoethane (EDB)	0.50	Not Detected	3.8	Not Detected
Chlorobenzene	0.50	Not Detected	2.3	Not Detected
Ethyl Benzene	0.50	Not Detected	2.2	Not Detected
m,p-Xylene	0.50	Not Detected	2.2	Not Detected
o-Xylene	0.50	Not Detected	2.2	Not Detected
Styrene	0.50	Not Detected	2.1	Not Detected
Bromoform	0.50	Not Detected	5.2	Not Detected
Cumene	0.50	Not Detected	2.4	Not Detected
1,1,2,2-Tetrachloroethane	0.50	Not Detected	3.4	Not Detected
Propylbenzene	0.50	Not Detected	2.4	Not Detected
4-Ethyltoluene	0.50	Not Detected	2.4	Not Detected
1,3,5-Trimethylbenzene	0.50	Not Detected	2.4	Not Detected
1,2,4-Trimethylbenzene	0.50	Not Detected	2.4	Not Detected
1,3-Dichlorobenzene	0.50	Not Detected	3.0	Not Detected
1,4-Dichlorobenzene	0.50	Not Detected	3.0	Not Detected
alpha-Chlorotoluene	0.50	Not Detected	2.6	Not Detected
1,2-Dichlorobenzene	0.50	Not Detected	3.0	Not Detected
1,2,4-Trichlorobenzene	2.0	Not Detected	15	Not Detected
Hexachlorobutadiene	2.0	Not Detected	21	Not Detected

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Toluene-d8	100	70-130
1,2-Dichloroethane-d4	96	70-130
4-Bromofluorobenzene	94	70-130

AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: Lab Blank

Lab ID#: 0604225R1-04B

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**1041406**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 4/14/06 01:57 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Freon 12	0.50	Not Detected	2.5	Not Detected
Freon 114	0.50	Not Detected	3.5	Not Detected
Chloromethane	2.0	Not Detected	4.1	Not Detected
Vinyl Chloride	0.50	Not Detected	1.3	Not Detected
1,3-Butadiene	0.50	Not Detected	1.1	Not Detected
Bromomethane	0.50	Not Detected	1.9	Not Detected
Chloroethane	0.50	Not Detected	1.3	Not Detected
Freon 11	0.50	Not Detected	2.8	Not Detected
Ethanol	2.0	Not Detected	3.8	Not Detected
Freon 113	0.50	Not Detected	3.8	Not Detected
1,1-Dichloroethene	0.50	Not Detected	2.0	Not Detected
Acetone	2.0	Not Detected	4.8	Not Detected
2-Propanol	2.0	Not Detected	4.9	Not Detected
Carbon Disulfide	0.50	Not Detected	1.6	Not Detected
3-Chloropropene	2.0	Not Detected	6.3	Not Detected
Methylene Chloride	0.50	Not Detected	1.7	Not Detected
Methyl tert-butyl ether	0.50	Not Detected	1.8	Not Detected
trans-1,2-Dichloroethene	0.50	Not Detected	2.0	Not Detected
Hexane	0.50	Not Detected	1.8	Not Detected
1,1-Dichloroethane	0.50	Not Detected	2.0	Not Detected
2-Butanone (Methyl Ethyl Ketone)	0.50	Not Detected	1.5	Not Detected
cis-1,2-Dichloroethene	0.50	Not Detected	2.0	Not Detected
Tetrahydrofuran	0.50	Not Detected	1.5	Not Detected
Chloroform	0.50	Not Detected	2.4	Not Detected
1,1,1-Trichloroethane	0.50	Not Detected	2.7	Not Detected
Cyclohexane	0.50	Not Detected	1.7	Not Detected
Carbon Tetrachloride	0.50	Not Detected	3.1	Not Detected
2,2,4-Trimethylpentane	0.50	Not Detected	2.3	Not Detected
Benzene	0.50	Not Detected	1.6	Not Detected
1,2-Dichloroethane	0.50	Not Detected	2.0	Not Detected
Heptane	0.50	Not Detected	2.0	Not Detected
Trichloroethene	0.50	Not Detected	2.7	Not Detected
1,2-Dichloropropane	0.50	Not Detected	2.3	Not Detected
1,4-Dioxane	2.0	Not Detected	7.2	Not Detected
Bromodichloromethane	0.50	Not Detected	3.4	Not Detected
cis-1,3-Dichloropropene	0.50	Not Detected	2.3	Not Detected
4-Methyl-2-pentanone	0.50	Not Detected	2.0	Not Detected
Toluene	0.50	Not Detected	1.9	Not Detected
trans-1,3-Dichloropropene	0.50	Not Detected	2.3	Not Detected
1,1,2-Trichloroethane	0.50	Not Detected	2.7	Not Detected

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AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: Lab Blank

Lab ID#: 0604225R1-04B

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**1041406**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 4/14/06 01:57 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Tetrachloroethene	0.50	Not Detected	3.4	Not Detected
2-Hexanone	2.0	Not Detected	8.2	Not Detected
Dibromochloromethane	0.50	Not Detected	4.2	Not Detected
1,2-Dibromoethane (EDB)	0.50	Not Detected	3.8	Not Detected
Chlorobenzene	0.50	Not Detected	2.3	Not Detected
Ethyl Benzene	0.50	Not Detected	2.2	Not Detected
m,p-Xylene	0.50	Not Detected	2.2	Not Detected
o-Xylene	0.50	Not Detected	2.2	Not Detected
Styrene	0.50	Not Detected	2.1	Not Detected
Bromoform	0.50	Not Detected	5.2	Not Detected
Cumene	0.50	Not Detected	2.4	Not Detected
1,1,2,2-Tetrachloroethane	0.50	Not Detected	3.4	Not Detected
Propylbenzene	0.50	Not Detected	2.4	Not Detected
4-Ethyltoluene	0.50	Not Detected	2.4	Not Detected
1,3,5-Trimethylbenzene	0.50	Not Detected	2.4	Not Detected
1,2,4-Trimethylbenzene	0.50	Not Detected	2.4	Not Detected
1,3-Dichlorobenzene	0.50	Not Detected	3.0	Not Detected
1,4-Dichlorobenzene	0.50	Not Detected	3.0	Not Detected
alpha-Chlorotoluene	0.50	Not Detected	2.6	Not Detected
1,2-Dichlorobenzene	0.50	Not Detected	3.0	Not Detected
1,2,4-Trichlorobenzene	2.0	Not Detected	15	Not Detected
Hexachlorobutadiene	2.0	Not Detected	21	Not Detected

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Toluene-d8	98	70-130
1,2-Dichloroethane-d4	95	70-130
4-Bromofluorobenzene	102	70-130

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AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: CCV

Lab ID#: 0604225R1-05A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**1041305**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 4/13/06 01:12 PM**

Compound	%Recovery
Freon 12	90
Freon 114	109
Chloromethane	100
Vinyl Chloride	88
1,3-Butadiene	95
Bromomethane	101
Chloroethane	86
Freon 11	96
Ethanol	96
Freon 113	99
1,1-Dichloroethene	97
Acetone	97
2-Propanol	100
Carbon Disulfide	99
3-Chloropropene	102
Methylene Chloride	108
Methyl tert-butyl ether	99
trans-1,2-Dichloroethene	94
Hexane	100
1,1-Dichloroethane	100
2-Butanone (Methyl Ethyl Ketone)	106
cis-1,2-Dichloroethene	101
Tetrahydrofuran	95
Chloroform	100
1,1,1-Trichloroethane	99
Cyclohexane	101
Carbon Tetrachloride	102
2,2,4-Trimethylpentane	100
Benzene	100
1,2-Dichloroethane	103
Heptane	103
Trichloroethene	103
1,2-Dichloropropane	104
1,4-Dioxane	102
Bromodichloromethane	109
cis-1,3-Dichloropropene	105
4-Methyl-2-pentanone	111
Toluene	102
trans-1,3-Dichloropropene	103
1,1,2-Trichloroethane	100

AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: CCV

Lab ID#: 0604225R1-05A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**1041305**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 4/13/06 01:12 PM**

Compound	%Recovery
Tetrachloroethene	102
2-Hexanone	105
Dibromochloromethane	109
1,2-Dibromoethane (EDB)	104
Chlorobenzene	97
Ethyl Benzene	97
m,p-Xylene	94
o-Xylene	94
Styrene	102
Bromoform	107
Cumene	89
1,1,2,2-Tetrachloroethane	91
Propylbenzene	88
4-Ethyltoluene	87
1,3,5-Trimethylbenzene	82
1,2,4-Trimethylbenzene	81
1,3-Dichlorobenzene	81
1,4-Dichlorobenzene	80
alpha-Chlorotoluene	83
1,2-Dichlorobenzene	78
1,2,4-Trichlorobenzene	85
Hexachlorobutadiene	90

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Toluene-d8	98	70-130
1,2-Dichloroethane-d4	95	70-130
4-Bromofluorobenzene	98	70-130

AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: CCV

Lab ID#: 0604225R1-05B

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**1041402**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 4/14/06 11:08 AM**

Compound	%Recovery
Freon 12	87
Freon 114	105
Chloromethane	96
Vinyl Chloride	83
1,3-Butadiene	92
Bromomethane	97
Chloroethane	80
Freon 11	99
Ethanol	88
Freon 113	100
1,1-Dichloroethene	97
Acetone	91
2-Propanol	94
Carbon Disulfide	96
3-Chloropropene	100
Methylene Chloride	102
Methyl tert-butyl ether	95
trans-1,2-Dichloroethene	90
Hexane	96
1,1-Dichloroethane	98
2-Butanone (Methyl Ethyl Ketone)	100
cis-1,2-Dichloroethene	99
Tetrahydrofuran	89
Chloroform	100
1,1,1-Trichloroethane	100
Cyclohexane	97
Carbon Tetrachloride	103
2,2,4-Trimethylpentane	98
Benzene	99
1,2-Dichloroethane	103
Heptane	98
Trichloroethene	103
1,2-Dichloropropane	104
1,4-Dioxane	94
Bromodichloromethane	106
cis-1,3-Dichloropropene	106
4-Methyl-2-pentanone	104
Toluene	102
trans-1,3-Dichloropropene	103
1,1,2-Trichloroethane	99

AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: CCV

Lab ID#: 0604225R1-05B

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**1041402**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 4/14/06 11:08 AM**

Compound	%Recovery
Tetrachloroethene	101
2-Hexanone	96
Dibromochloromethane	105
1,2-Dibromoethane (EDB)	104
Chlorobenzene	96
Ethyl Benzene	95
m,p-Xylene	92
o-Xylene	92
Styrene	101
Bromoform	101
Cumene	87
1,1,2,2-Tetrachloroethane	88
Propylbenzene	86
4-Ethyltoluene	83
1,3,5-Trimethylbenzene	79
1,2,4-Trimethylbenzene	78
1,3-Dichlorobenzene	79
1,4-Dichlorobenzene	78
alpha-Chlorotoluene	79
1,2-Dichlorobenzene	75
1,2,4-Trichlorobenzene	86
Hexachlorobutadiene	89

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Toluene-d8	100	70-130
1,2-Dichloroethane-d4	98	70-130
4-Bromofluorobenzene	98	70-130

AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: LCS

Lab ID#: 0604225R1-06A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**1041304**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 4/13/06 12:05 PM**

Compound	%Recovery
Freon 12	90
Freon 114	112
Chloromethane	99
Vinyl Chloride	89
1,3-Butadiene	109
Bromomethane	106
Chloroethane	90
Freon 11	98
Ethanol	102
Freon 113	101
1,1-Dichloroethene	98
Acetone	104
2-Propanol	102
Carbon Disulfide	112
3-Chloropropene	128
Methylene Chloride	111
Methyl tert-butyl ether	103
trans-1,2-Dichloroethene	101
Hexane	107
1,1-Dichloroethane	101
2-Butanone (Methyl Ethyl Ketone)	114
cis-1,2-Dichloroethene	103
Tetrahydrofuran	97
Chloroform	101
1,1,1-Trichloroethane	102
Cyclohexane	105
Carbon Tetrachloride	104
2,2,4-Trimethylpentane	119
Benzene	102
1,2-Dichloroethane	104
Heptane	103
Trichloroethene	105
1,2-Dichloropropane	106
1,4-Dioxane	97
Bromodichloromethane	106
cis-1,3-Dichloropropene	91
4-Methyl-2-pentanone	110
Toluene	103
trans-1,3-Dichloropropene	102
1,1,2-Trichloroethane	103

AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: LCS

Lab ID#: 0604225R1-06A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**1041304**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 4/13/06 12:05 PM**

Compound	%Recovery
Tetrachloroethene	104
2-Hexanone	101
Dibromochloromethane	105
1,2-Dibromoethane (EDB)	107
Chlorobenzene	100
Ethyl Benzene	103
m,p-Xylene	93
o-Xylene	86
Styrene	105
Bromoform	92
Cumene	103
1,1,2,2-Tetrachloroethane	92
Propylbenzene	105
4-Ethyltoluene	99
1,3,5-Trimethylbenzene	75
1,2,4-Trimethylbenzene	58 Q
1,3-Dichlorobenzene	80
1,4-Dichlorobenzene	79
alpha-Chlorotoluene	93
1,2-Dichlorobenzene	75
1,2,4-Trichlorobenzene	73
Hexachlorobutadiene	74

Q = Exceeds Quality Control limits.

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Toluene-d8	100	70-130
1,2-Dichloroethane-d4	97	70-130
4-Bromofluorobenzene	99	70-130

@ AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: LCS

Lab ID#: 0604225R1-06B

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**1041403**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 4/14/06 11:46 AM**

Compound	%Recovery
Freon 12	87
Freon 114	109
Chloromethane	102
Vinyl Chloride	86
1,3-Butadiene	108
Bromomethane	102
Chloroethane	85
Freon 11	97
Ethanol	99
Freon 113	99
1,1-Dichloroethene	96
Acetone	102
2-Propanol	100
Carbon Disulfide	111
3-Chloropropene	125
Methylene Chloride	108
Methyl tert-butyl ether	102
trans-1,2-Dichloroethene	100
Hexane	105
1,1-Dichloroethane	100
2-Butanone (Methyl Ethyl Ketone)	111
cis-1,2-Dichloroethene	101
Tetrahydrofuran	96
Chloroform	99
1,1,1-Trichloroethane	100
Cyclohexane	103
Carbon Tetrachloride	103
2,2,4-Trimethylpentane	118
Benzene	100
1,2-Dichloroethane	104
Heptane	102
Trichloroethene	103
1,2-Dichloropropane	105
1,4-Dioxane	97
Bromodichloromethane	105
cis-1,3-Dichloropropene	90
4-Methyl-2-pentanone	110
Toluene	102
trans-1,3-Dichloropropene	100
1,1,2-Trichloroethane	100

AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: LCS

Lab ID#: 0604225R1-06B

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**1041403**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 4/14/06 11:46 AM**

Compound	%Recovery
Tetrachloroethene	102
2-Hexanone	99
Dibromochloromethane	103
1,2-Dibromoethane (EDB)	103
Chlorobenzene	97
Ethyl Benzene	99
m,p-Xylene	90
o-Xylene	85
Styrene	102
Bromoform	89
Cumene	100
1,1,2,2-Tetrachloroethane	89
Propylbenzene	101
4-Ethyltoluene	95
1,3,5-Trimethylbenzene	72
1,2,4-Trimethylbenzene	56 Q
1,3-Dichlorobenzene	77
1,4-Dichlorobenzene	76
alpha-Chlorotoluene	90
1,2-Dichlorobenzene	72
1,2,4-Trichlorobenzene	71
Hexachlorobutadiene	73

Q = Exceeds Quality Control limits.

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Toluene-d8	100	70-130
1,2-Dichloroethane-d4	97	70-130
4-Bromofluorobenzene	97	70-130

Environmental Resources Management

CHAIN OF CUSTODY RECORD

0604225

NO: 4515

1777 Botelho Drive, Suite 260 • Walnut Creek, CA • 94596 • (925) 946-0455 • FAX (925) 946-9968

Page 1 of 1

PROJECT #: 20577.10

PROJECT NAME: Hookston Station

SAMPLER: (PRINT NAME): Rob Dyer

(SIGNATURE): Rob Dyer

RECEIVING LABORATORY: Air Toxics

	SAMPLE I.D.	DATE	TIME	COMP	GRAB	SAMPLING METHOD	PRESER-VATIVE	ICE (Y/N)	SAMPLING VOLUME	# OF CONTAINERS	SOIL	WATER	GAS	TO-15
1A	SVE T1	4-11-06	12:16		x	Tedlar	N	N	Tedlar	1			x	x
2A	SVE T2	4/11-06	12:26		x	Tedlar	N	N	Tedlar	1			x	x
3A	SVE T3	4-11-06	12:40		x	Tedlar	N	N	Tedlar	1			x	x

RGD

RGD

CUSTODY SEAL INTACT?
Y N NONE TEMP —

FedEx: 727028197254

RELINQUISHED BY (SIGNATURE)	DATE	TIME	RECEIVED BY	DATE	TIME
Rob Dyer	4-12-06	11:30	[signature] ATL	4/13/06	0930

FIELD REMARKS

5 day T.A.T.

Please send E.D.F. to rob.dyer@erm.com

REMARKS ON SAMPLE RECEIPT

☐ BOTTLE INTACT ☐ CUSTODY SEALS ☐ CHILLED
☐ PRESERVED ☐ SEALS INTACT ☐ SEE REMARKS

ERM REMARKS

SEND REPORT TO: Rob Dyer

WHITE – LABORATORY COPY CANARY – FIELD COPY PINK – DATABASE GOLD – PROJECT FILE

Attachment D
Data Evaluation Computations

Attachment D-1
SVE Pilot Test - Performance Testing System Readings
Hookston Station
Pleasant Hill, California

Baselin Readings				
Location	Time	Depth to Water (ft)	PID Reading	Gage Pressure (in H2O)
TW-1	9:30	14.51	6	0
TW-2	9:30	14.52	6	0
TW-3	9:35	14.58	3	0

System Readings								
Time	Applied Vacuum (in H2O)	Temp (F)	Temp (C)	Velocity (fpm)	Flow (acfm)	Flow (scfm)	Influent PID Reading	Effluent PID Reading
12:07	10	63.1	17.2	545	107	106	6	0
12:10	60	66.1	18.8	615	121	112	3	0
12:13	94	64.7	18.1	890	175	154	6	0
12:16	145	64.3	17.8	920	181	146	10	0
12:20	250	64.5	17.9	880	173	108	20	0
12:26	300	64.2	17.8	950	187	97	33	NM
12:36	340	63.7	17.5	945	186	77	NM	NM

Notes:
NM = Not Measured

Attachment D-2
SVE Pilot Test - Soil Air Permeability Calculations for Transient Conditions
Hookston Station
Pleasant Hill, California

Under transient conditions, from Johnson et al 1990:

$$P' = \frac{Q\mu}{4\pi bK}[-0.5772 - \ln(\frac{r^2 E\mu}{4KP_{atm}}) + \ln(t)$$

Where:

P′ = Gage pressure at a distance r and time t	r = radial distance from extraction well
Q = Volumetric Flow rate	E = air filled soil void fraction
μ = viscosity of air	P_{atm} = atmospheric pressure
b = stratum thickness	t = time
K = soil permeability to air flow	

At a given distance r, this equation can be rewritten as:

$$P'(\ln(t)) = A\ln(t) + B$$

Where A is the slope of the plot of P' vs. ln(t) and is equal to:

$$A = \frac{Q\mu}{4\pi bK}$$

From the plot of observed change in pressure with respect to time we get the following slopes:

TW-2	0.5372 in H_20	or	89.93 $lbm/ft \cdot s^2$
TW-3	1.889 in H_20	or	316.22 $lbm/ft \cdot s^2$
TW-4	0.3557 in H_20	or	59.54 $lbm/ft \cdot s^2$

note: $$1inH_2O = 0.036\frac{lbf}{in^2}\left(\frac{144\,in^2}{ft^2}\right)\left(\frac{32.2lbm\cdot ft}{s^2\cdot lbf}\right) = 167.4\frac{lbm}{ft\cdot s^2}$$

Knowing that:

$$A = \frac{Q\mu}{4\pi bK}$$

The permeability can be calculated by rearranging the equation and solving for K:

$$K = \frac{Q\mu}{4\pi bA}$$

Given the calculated slopes and the following field data:

Q =	145	scfm	or	2.42 scfs
b =	12	ft		
μ =	1.20E-05	$lbm/ft \cdot s$		
A_{TW-2} =	89.93	$lbm/ft \cdot s^2$		
A_{TW-3} =	316.22	$lbm/ft \cdot s^2$		
A_{TW-4} =	59.54	$lbm/ft \cdot s^2$		

$$K_{TW-2} = \frac{2.42\left(\frac{ft^3}{s}\right) \cdot 1.2 \times 10^{-5}\left(\frac{lbm}{ft \cdot s}\right)}{4 \cdot \pi \cdot 12(ft) \cdot 89.9\left(\frac{lbm}{ft \cdot s^2}\right)} = 2.14 \times 10^{-9}\, ft^2$$

K_{TW-2} =	2.13853E-09	ft^2	=	201 darcy
K_{TW-3} =	6.08161E-10	ft^2	=	57 darcy
K_{TW-4} =	3.22973E-09	ft^2	=	304 darcy

note:

$$9.41 \times 10^{10}\left(\frac{darcy}{ft^2}\right)$$

Attachment D-3
SVE Pilot Test - Soil Air Permeability Calculations for Steady-State Conditions
Hookston Station
Pleasant Hill, California

Under steady-state conditions from the USACE Manual:

$$K = \left(\frac{Q\mu P_W}{\pi b}\right)\frac{\ln\left(R_2 / \quad R_1\right)}{P_2^{\ 2} - P_1^{\ 1}}$$

Where:
K = soil permeability to air flow
Q = Volumetric Flow rate
μ = viscosity of air
b = stratum thickness
P_w = absolute pressure at extraction well
$R_{1,2}$ = radial distance from extraction well to observation points
$P_{1,2}$ = absolute pressure at monitoring points

Given the following field data:

b =	12	ft
μ =	1.20E-05	lbm/ft*s
Rw =	0.167	ft
R_{TW-3} =	5	ft
R_{TW-4} =	10	ft
R_{TW-2} =	20	ft

Given the following steady state conditions:

Q =	145	scfm	or	2.42	scfs
P_w =	319.2	in H_20	or	5.33E+04	lbm/ft*s^2
P_{TW-3} =	404.5	in H_20	or	6.76E+04	lbm/ft*s^2
P_{TW-4} =	408.8	in H_20	or	6.83E+04	lbm/ft*s^2
P_{TW-2} =	408.3	in H_20	or	6.82E+04	lbm/ft*s^2

The following soil permeabilities are calculated:

$K_{TW-2,3}$ =	6.60E-10	ft^2	(9.4135 E10 darcy/ft^2)	=	62 darcy
$K_{TW-4,3}$ =	2.92E-10	ft^2	(9.4135 E10 darcy/ft^2)	=	27 darcy

Using the steady-state equation:

$$K = \left(\frac{Q \mu P_W}{\pi b} \right) \frac{\ln\left(R_2 / \ R_1\right)}{P_2^{\ 2} - P_1^{\ 1}}$$

In order to determine the radial distance that we would find a given pressure the equation is rearranged.

Solving for R_2:

$$R_2 = e^{\left(\frac{\pi b K \left(P_2^{\ 2} - P_1^{\ 2}\right)}{Q \mu P_W} \right)} R_1$$

Where:
K = soil permeability to air flow
μ = viscosity of air
Q = Volumetric Flow rate
b = stratum thickness
P_w = absolute pressure at extraction well
$P_{1,2}$ = absolute pressure at monitoring points
$R_{1,2}$ = radial distance from extraction well to observation points

Given the following field data:

Q =	2.42	scfs				
b =	12	ft				
K =	60	darcy	(9.41 E10 darcy/ft^2) =		6.38E-10	ft^2
μ =	1.20E-05	lbm/ft*s				
R_{TW-3} =	5	ft				
P_w =	319.2	in H_20	or		5.33E+04	lbm/ft*s^2
P_{TW-3} =	404.5	in H_20	or		6.76E+04	lbm/ft*s^2

Assuming:

P_2 =	409.19	in H_20	or	6.83E+04	lbm/ft*s^2

Then

R_2 =	26.14	ft

It is currently recommended that a minimum pore gas velocity of 3 to 30 ft/day be used for the design criteria for determining the radius of influence.

Using Darcy's Law:

$$q_s = \frac{K}{\mu \eta_a}\left(\frac{dP}{dS}\right)$$

Where:
q_s = flow velocity
K = soil permeability to air flow
μ = viscosity of air
η_a = air filled porosity
dP/dS = pressure gradient

Given the following field data:

K =	60	darcy	(9.41 E10 darcy/ft^2) =	6.38E-10	ft^2
μ =	1.20E-05	lbm/ft*s			
η_a =	30	%			

Where:

$$\frac{dP}{dS} = \frac{\text{(Applied Extraction Vaccum* vent efficiency) - vacuum at monitoring point}}{\text{distance from extraction well to monitoring point}}$$

Given that:
Applied ExtractionVacuum = 90 in H_20
Calculated vacuum = 0.01 in H_20
Assuming:
vent efficiency = 10 %

$$\frac{dP}{dS} = 0.34 \ \frac{\text{inH}_2\text{O}}{\text{ft}} \left(\frac{\text{lbf/in}^2}{27.7 \text{ inH}_2\text{O}}\right)\left(\frac{144 \text{ in}^2}{\text{ft}^2}\right)\left(\frac{32.2 \text{ lbm*ft/s}^2}{1 \text{ lbf}}\right)$$

$$\frac{dP}{dS} = 57.57 \ \frac{\text{lbm}}{\text{ft}^2\text{*s}^2}$$

$$q_s = \frac{K}{\mu \eta_a}\left(\frac{dP}{dS}\right) = \left(\frac{6.38\text{E-10 ft}^2}{1.20\text{E-05} \quad \text{lbm/ft*s} \quad 0.3}\right)\left(57.57 \quad \frac{\text{lbm}}{\text{ft}^2\text{*s}^2}\right)$$

q_s = 0.010196 ft/s = 15 ft/day

SVE T_1 VOC Concentrations:			
1,1 DCE conc.[1]	=	100	ug/m^3
cis 1,2 DCE conc.[1]	=	34	ug/m^3
TCE conc.[1]	=	8,900	ug/m^3
PCE conc.[1]	=	48	ug/m^3
Total VOC conc.	=	9,082	ug/m^3

SVE T_2 VOC Concentrations:			
1,1 DCE conc.[1]	=	540	ug/m^3
cis 1,2 DCE conc.[1]	=	150	ug/m^3
TCE conc.[1]	=	39,000	ug/m^3
PCE conc.[1]	=	180	ug/m^3
Total VOC conc.	=	39,870	ug/m^3

SVE T_3 VOC Concentrations:			
1,1 DCE conc.[1]	=	950	ug/m^3
cis 1,2 DCE conc.[1]	=	320	ug/m^3
TCE conc.[1]	=	76,000	ug/m^3
PCE conc.[1]	=	370	ug/m^3
Total VOC conc.	=	77,640	ug/m^3

Average VOC Concentrations:			
Avg. 1,1 DCE conc.[1]	=	530	ug/m^3
Avg. cis 1,2 DCE conc.[1]	=	168	ug/m^3
Avg. TCE conc.[1]	=	41,300	ug/m^3
Avg. PCE conc.[1]	=	199	ug/m^3
Avg. Total VOC conc.	=	42,197	ug/m^3

<u>1,1 DCE</u>

Max. Daily Extraction Rate	=	6	g/day	or	0.01	lbs/day
Avg. Daily Extraction Rate	=	3	g/day	or	0.01	lbs/day
Estimated Mass Extracted	=	0.77	g	or	0.00	lbs

<u>cis 1,2 DCE</u>

Max. Daily Extraction	=	2	g/day	or	0.00	lbs/day
Avg. Daily Extraction	=	1	g/day	or	0.00	lbs/day
Estimated Mass Extracted	=	0.24	g	or	0.00	lbs

<u>TCE</u>

Max. Daily Extraction	=	449	g/day	or	0.99	lbs/day
Avg. Daily Extraction	=	244	g/day	or	0.54	lbs/day
Estimated Mass Extracted	=	60	g	or	0.13	lbs

<u>PCE</u>

Max. Daily Extraction Rate	=	2	g/day	or	0.00	lbs/day
Avg. Daily Extraction Rate	=	1	g/day	or	0.00	lbs/day
Estimated Mass Extracted	=	0.29	g	or	0.00	lbs

<u>Total VOCs</u>

Max. Daily Extraction	=	459	g/day	or	1.01	lbs/day
Avg. Daily Extraction	=	249	g/day	or	0.55	lbs/day
Estimated Mass Extracted	=	61	g	or	0.13	lbs

<u>Notes:</u>
[1]Based on an average of the three vapor samples collected
Daily Extraction Rate = ([Conc] ug/m3) * (.001 m3/L)* ([flow rate] ft3/min) * (28.317 L/ft3)*(1440 min/day)
Average Flow Rate = 145 scfm
VOC = volatile organic compounds
DCE = dichloroethene
TCE = trichloroethene
PCE = tetrachloroethene
scfm=standard cubic foot per minute

Appendix F
Geotechnical Laboratory Report

Table F-1
Soil Geotechnical Results
Hookston Station
Pleasant Hill, California

Sample Location	Sample Depth (feet)	Visual Description	Aquifer Zone	% gravel	% sand	%silt	% clay	Organic Content (%)	Specific Gravity	Dry Bulk Density (g/cm^3)	Total Porosity (%)	Effective Porosity (%)	Air-filled Porosity (%)	Water-filled Porosity (%)	Moisture (%)	Percent Saturation (%)	Hydraulic Conductivity (cm/sec)
				Grain Size Distribution													
				ASTM D422				*Walkley-Black*	*ASTM D 854m*	*API RP40 and ASTM D2325m*						*ASTM D 5084*	
October 2003																	
B-73	7.5-9	na	Vadose	0.0	11.2	41.3	47.5	4.6*	2.60	1.51†	41.9†	na	na	na	na	na	na
B-88	9.5	na	Vadose	0.0	4.2	39.8	56.0	4.7*	2.60	1.66†	36.2†	na	na	na	na	na	na
MW-13A	7	na	Vadose	0.0	19.2	38.9	41.9	3.7*	2.62	1.23†	53.1†	na	na	na	na	na	na
February 2004																	
MW-15A	15.5	na	A-Zone	15.6	60.2	14.9	9.3	1.1*	na	na	na	na	na	na	na	na	na
MW-15B	50	na	B-Zone	0.7	25.5	46.9	26.9	1.7*	na	na	na	na	na	na	na	na	na
MW-16A	16.5	na	A-Zone	0.0	38.1	43.1	18.8	1.5*	na	na	na	na	na	na	na	na	na
April 2006																	
TW-1	6.5	Dark Brown CLAY w/ sand	Vadose	0.0	22.7	47.4	29.9	0.2	2.72	1.62	40.4	2.1	4.0	36.4	22.4	90	na
TW-1	10	Mottled Light Brown Sandy CLAY	Vadose	0.0	34.7	44.2	21.1	<0.1	2.71	1.61	40.5	5.1	4.3	36.2	22.4	89.5	na
TW-1	30	Mottled greenish gray CLAY w/ sand	A-Zone	0.0	29.1	45.4	25.5	<0.1	2.71	1.49	45	1.7	0.7	44.2	29.6	98.4	$4.0x10^{-8}$
TW-1	39.5	Mottled dark gray CLAY	A-Zone	0.0	5.9	34.1	60	0.3	2.72	1.4	48.6	0.1	1.0	47.6	34	97.9	$1.0x10^{-8}$
TW-1	46.5	Greenish gray silty SAND w/gravel	B-Zone	19.3	64.7	10.5	5.5	<0.1	2.71	1.69	37.5	21.1	2.8	34.7	20.5	88.2	$5.0x10^{-7}$
TW-1	75	Greenish Gray CLAY w/ sand	B-Zone	1.2	27.8	40.5	30.5	<0.1	2.72	1.62	40.2	1.5	2.2	38.0	23.3	94.5	$2.0x10^{-8}$
TW-2	12	Mottled brown CLAY w/ sand	Vadose	1.0	21.2	46.2	31.6	<0.1	2.7	1.5	44.4	1.2	2.8	41.6	27.7	93.7	na
TW-2	19	Mottled grayish brown CLAY	A-Zone	0.0	11	57.3	31.7	<0.1	2.71	1.51	44.3	2.7	0.7	43.6	28.9	98.5	na
TW-3	7.5	Brown CLAY	Vadose	0.0	12.9	54.6	32.5	0.3	2.72	1.55	42.8	5.4	8.8	34.0	21.9	79.4	na
TW-3	14.5	Brown SILT	A-Zone	0.0	3.2	56.6	40.2	0.7	2.74	1.49	45.6	3.8	2.8	42.8	28.7	93.9	na
TW-3	21.5	Brown sandy-CLAY	A-Zone	0.0	40.7	34.9	24.4	<0.1	2.71	1.68	37.9	1	7.9	30.0	17.9	79.2	na
TW-4	7.5	Brown CLAY	Vadose	0.0	7	54.4	38.6	0.4	2.75	1.59	41.9	2.5	4.4	37.5	23.5	89.5	na
TW-4	17	Brown CLAY	A-Zone	0.0	5.5	49.6	44.9	0.6	2.72	1.45	46.7	3.4	3.0	43.7	30.1	93.6	na
SVE-1	11.5	Brown CLAY	Vadose	0.0	8.3	49.3	42.4	0.1	2.76	1.51	45.2	3.3	4.2	41.0	27.1	90.7	na

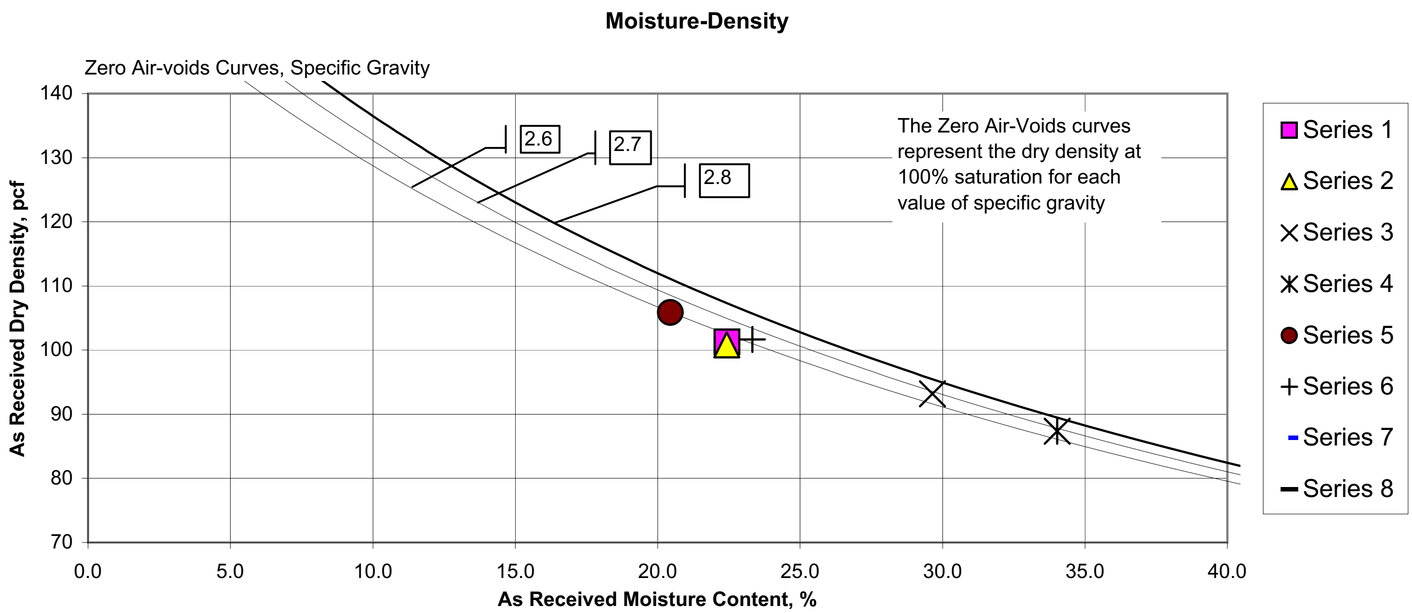
Notes:
ASTM = American Society for Testing and Materials
cm/sec = Centimeters per second
g/cm^3 = Gallons per cubic centimeter
* = Samples collected in 2003 and 2004 were analyzed for organic content using ASTM D 2974-00 Method C - 440 degrees Celsius
† = Samples collected in 2003 were analyzed for bulk density using method D2937 and porosity using D2937 and D854.

Total and Effective Porosity Report
(API RP40 and ASTM D2325m)

Job No: 586-004 **Project No.:** 0020557.10
Client: Environmental Resources Mgmt **Date:** 5/15/06
Project Name: Hookston **By:** PJ

Boring:	TW-1	TW-1	TW-1	TW-1	TW-1	TW-1		
Sample:								
Depth, ft:	6.5	10	30	39.5	46.5	75		
Visual Description:	Dark Brown CLAY w/ Sand	Mottled Light Brown Sandy CLAY	Mottled Greenish Gray CLAY w/ Sand	Mottled Dark Gray CLAY	Greenish Gray Silty SAND w/ Gravel	Greenish Gray CLAY w/ Sand		
Total Porosity, %	40.4	40.5	45.0	48.6	37.5	40.2		
Effective Porosity, %	2.1	5.1	1.7	0.1	6.7	1.5		
Air-filled Porosity, %	4.0	4.3	0.7	1.0	2.8	2.2		
Water-filled Porosity, %	36.4	36.2	44.2	47.6	34.7	38.0		
Saturation, %	94.7	87.5	96.2	99.8	82.0	92.1		
Moisture, %	22.4	22.4	29.6	34.0	20.5	23.3		
Wet Unit wt, pcf	124.0	123.4	120.8	117.1	127.5	125.4		
Dry Unit wt, pcf	101.3	100.8	93.2	87.4	105.9	101.7		
Series	1	2	3	4	5	6	7	8

Note: All reported values above are for the "as received" condition except for the effective porosity which is measured at a tension of 1/3 Bar.

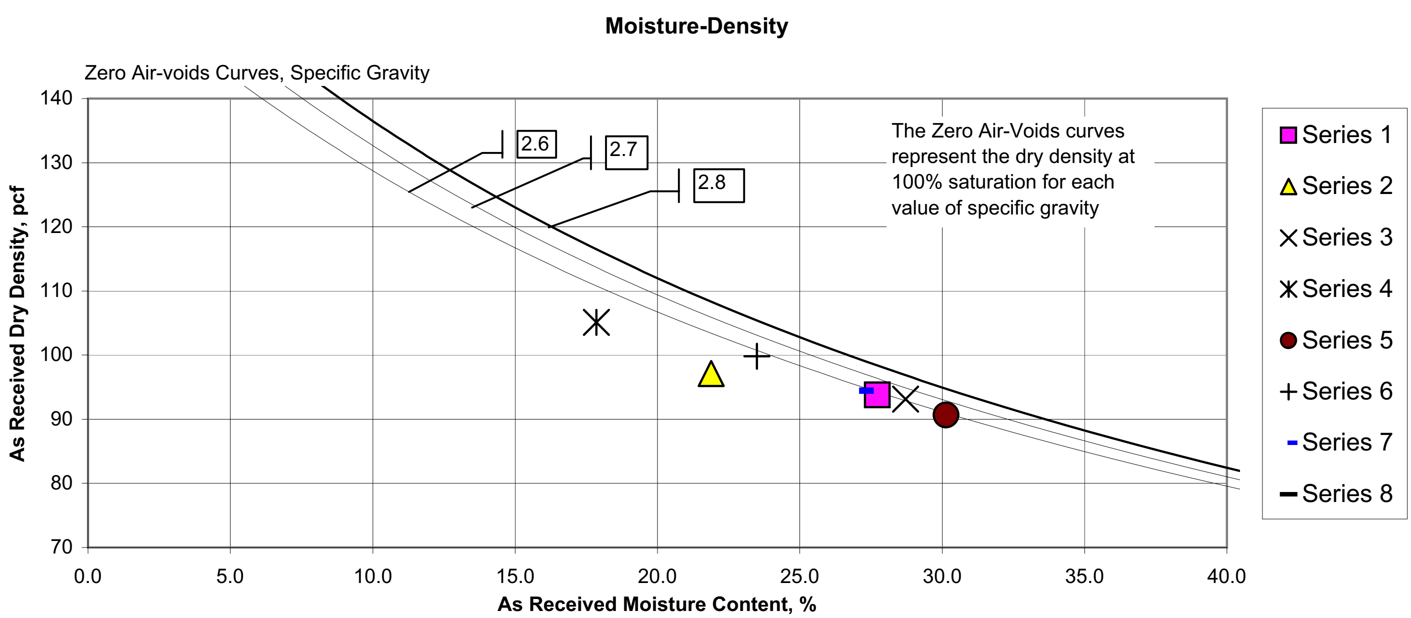


Total and Effective Porosity Report
(API RP40 and ASTM D2325m)

Job No: 586-005 **Project No.:** 0020557.10
Client: Environmental Resources Mgmt **Date:** 5/15/06
Project Name: Hookston **By:** PJ

Boring:	TW-2	TW-3	TW-3	TW-3	TW-4	TW-4	SVE-1	
Sample:								
Depth, ft:	12	7.5	14.5	21.5	17	7.5	11.5	
Visual Description:	Mottled Brown CLAY w/ Sand	Brown CLAY	Brown SILT	Brown Sandy CLAY	Brown CLAY	Brown CLAY	Brown CLAY	
Total Porosity, %	44.4	42.8	45.6	37.9	46.7	41.9	45.2	
Effective Porosity, %	1.2	5.4	3.8	1.0	3.4	2.5	3.3	
Air-filled Porosity, %	2.8	8.8	2.8	7.9	3.0	4.4	4.2	
Water-filled Porosity, %	41.6	34.0	42.8	30.0	43.7	37.5	41.0	
Saturation, %	97.2	87.5	91.6	97.4	92.8	93.9	93.9	
Moisture, %	27.7	21.9	28.7	17.9	30.1	23.5	27.1	
Wet Unit wt, pcf	119.8	118.4	119.9	123.8	117.9	123.2	120.1	
Dry Unit wt, pcf	93.8	97.1	93.1	105.1	90.6	99.8	94.4	
Series	1	2	3	4	5	6	7	8

Note: All reported values above are for the "as received" condition except for the effective porosity which is measured at a tension of 1/3 Bar.

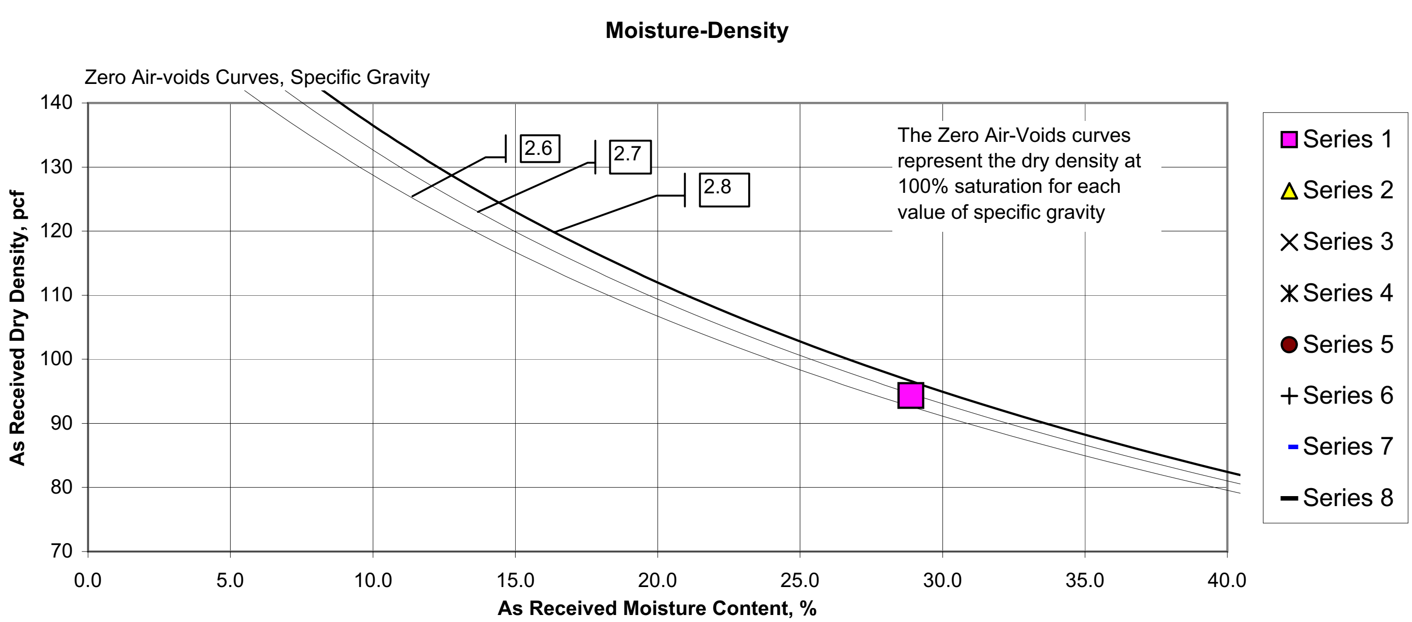


Total and Effective Porosity Report
(API RP40 and ASTM D2325m)

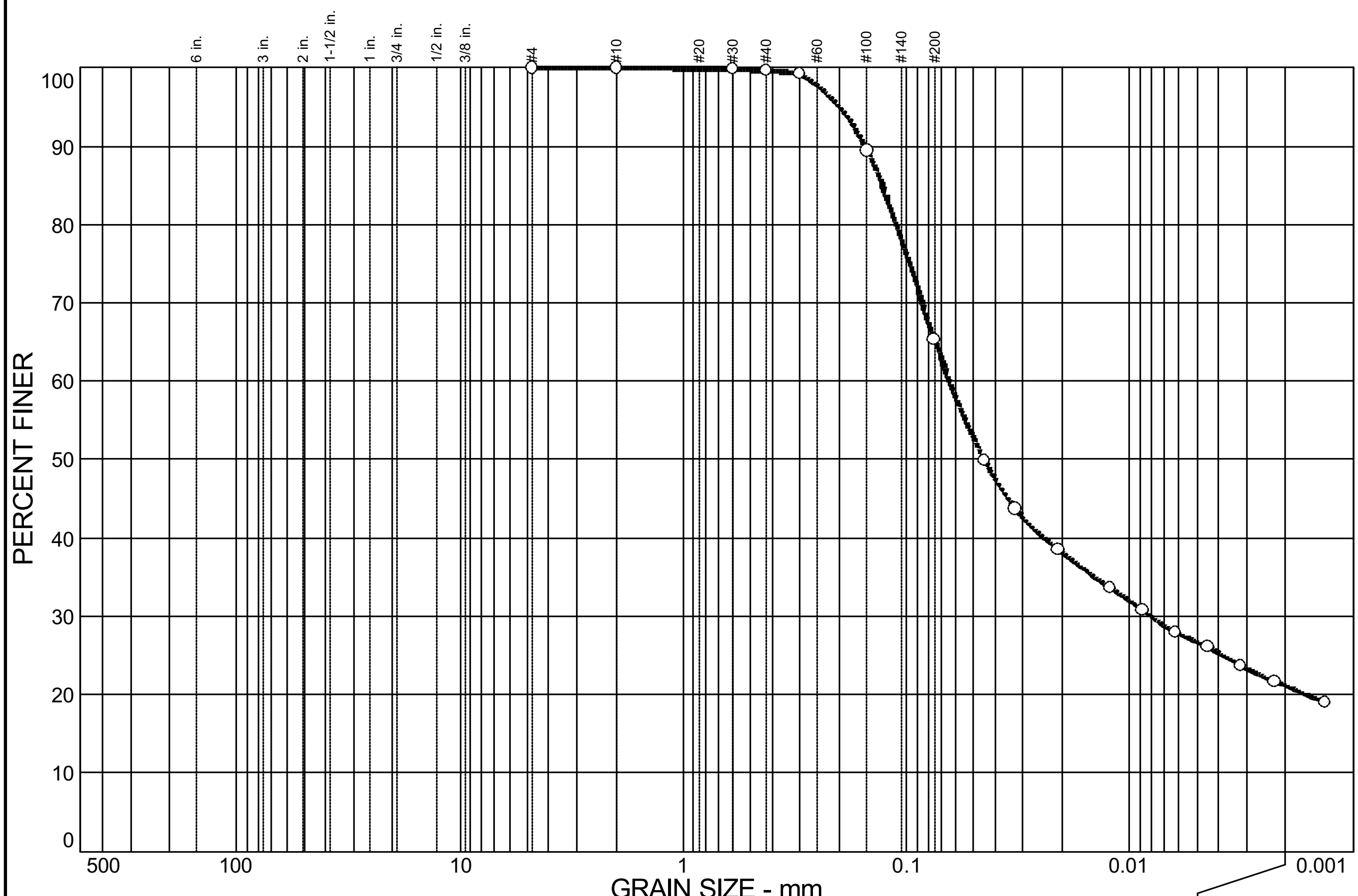
Job No: 586-006 **Project No.:** 0020557.10
Client: Environmental Resources Mgmt **Date:** 5/15/06
Project Name: Hookston **By:** PJ

Boring: **Sample:** **Depth, ft:**	TW-2 19							
Visual Description:	Mottled Grayish Brown CLAY							
Total Porosity, %	44.3							
Effective Porosity, %	2.7							
Air-filled Porosity, %	0.7							
Water-filled Porosity, %	43.6							
Saturation, %	94.1							
Moisture, %	28.9							
Wet Unit wt, pcf	121.6							
Dry Unit wt, pcf	94.3							
Series	1	2	3	4	5	6	7	8

Note: All reported values above are for the "as received" condition except for the effective porosity which is measured at a tension of 1/3 Bar.



PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	0.4	34.3	44.2	21.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#30	99.8		
#40	99.6		
#50	99.3		
#100	89.4		
#200	65.3		
0.0449 mm.	49.9		
0.0325 mm.	43.7		
0.0209 mm.	38.5		
0.0123 mm.	33.7		
0.0088 mm.	30.8		
0.0063 mm.	28.0		
0.0045 mm.	26.1		
0.0032 mm.	23.7		
0.0022 mm.	21.7		
0.0013 mm.	19.0		

* (no specification provided)

Soil Description

Mottled Light Brown Sandy CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.129 D_{60}= 0.0642 D_{50}= 0.0451
D_{30}= 0.0080 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

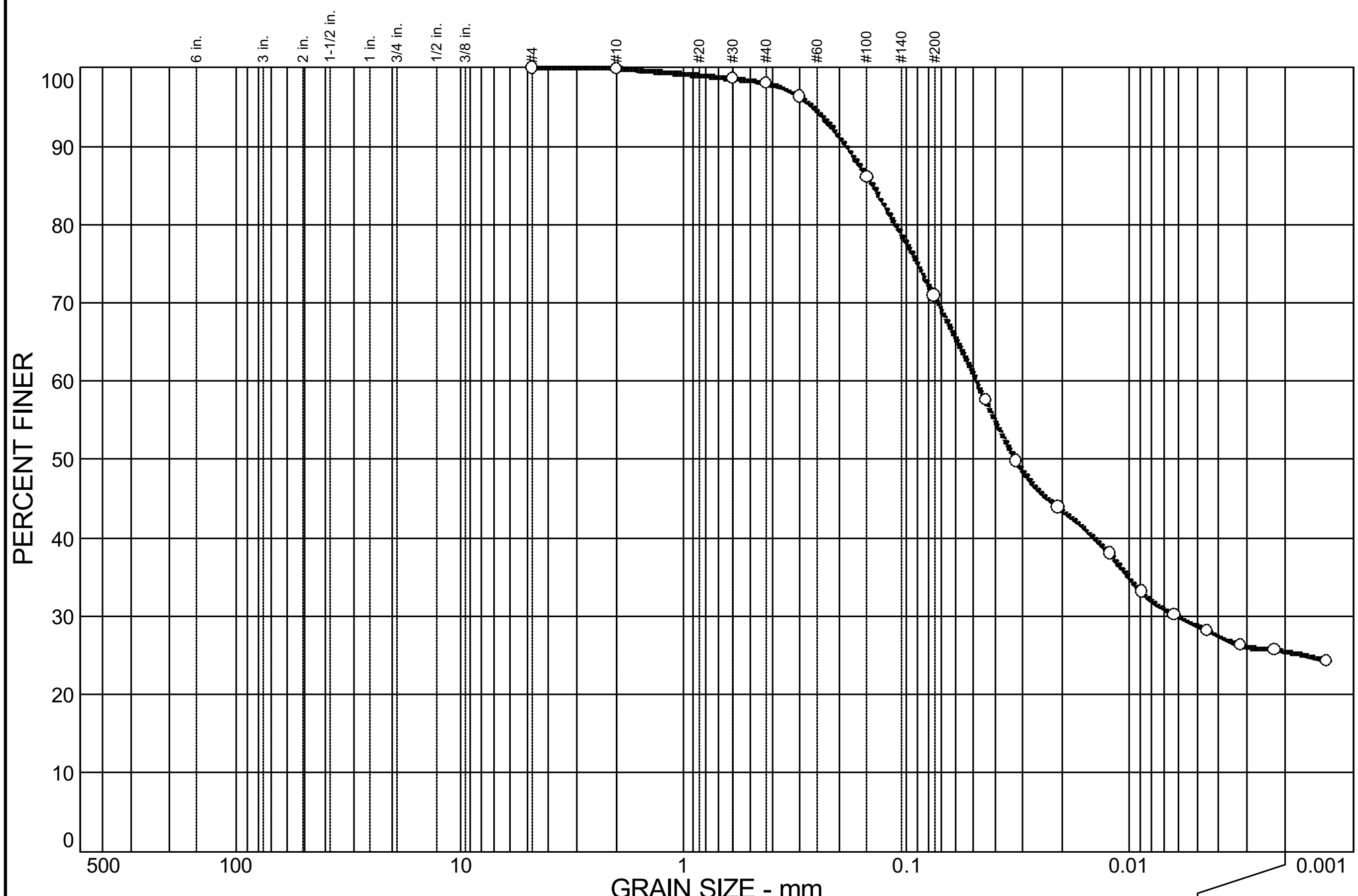
Sample No.: **Source of Sample:** TW-1 **Date:** 4/20/06
Location: **Elev./Depth:** 10'

COOPER TESTING LABORATORY

Client: Environmental Resources Management
Project: Hookston - 0020557.10

Project No: 586-004 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	1.9	27.1	45.4	25.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#30	98.6		
#40	98.0		
#50	96.3		
#100	86.0		
#200	70.9		
0.0443 mm.	57.6		
0.0323 mm.	49.8		
0.0208 mm.	43.9		
0.0123 mm.	38.0		
0.0088 mm.	33.1		
0.0063 mm.	30.2		
0.0045 mm.	28.2		
0.0032 mm.	26.3		
0.0022 mm.	25.7		
0.0013 mm.	24.3		

* (no specification provided)

Soil Description

Greenish Gray CLAY w/ Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.143 D_{60}= 0.0485 D_{50}= 0.0326
D_{30}= 0.0061 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

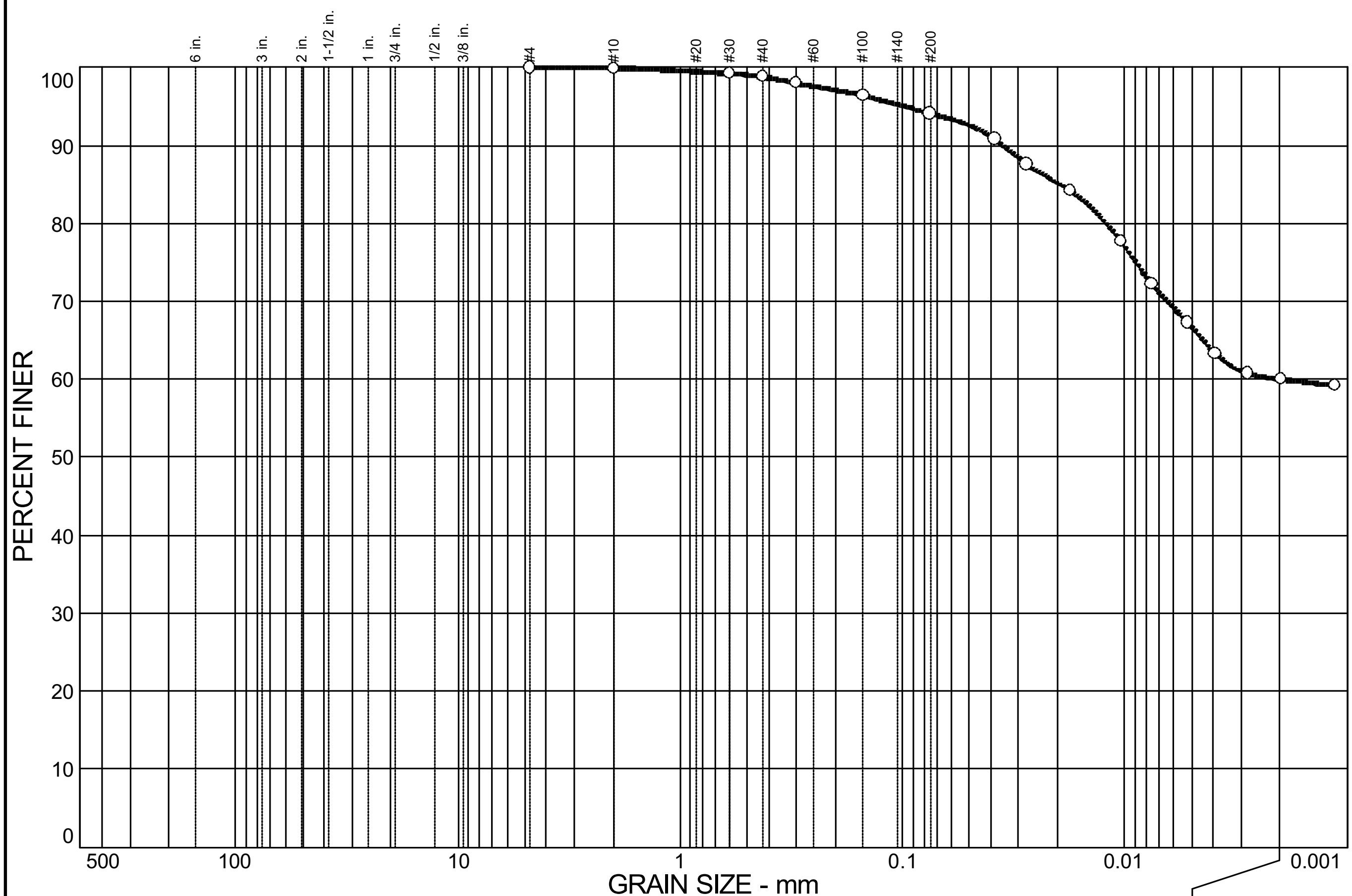
Sample No.: **Source of Sample:** TW-1 **Date:** 4/20/06
Location: **Elev./Depth:** 30'

COOPER TESTING LABORATORY

Client: Environmental Resources Management
Project: Hookston - 0020557.10

Project No: 586-004 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	1.1	4.7	34.1	60.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#30	99.2		
#40	98.8		
#50	98.0		
#100	96.4		
#200	94.1		
0.0383 mm.	90.8		
0.0275 mm.	87.6		
0.0175 mm.	84.2		
0.0104 mm.	77.7		
0.0075 mm.	72.2		
0.0052 mm.	67.3		
0.0039 mm.	63.3		
0.0028 mm.	60.8		
0.0020 mm.	60.0		
0.0011 mm.	59.2		

* (no specification provided)

Soil Description

Dark Gray CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.0194 D_{60}= 0.0020 D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

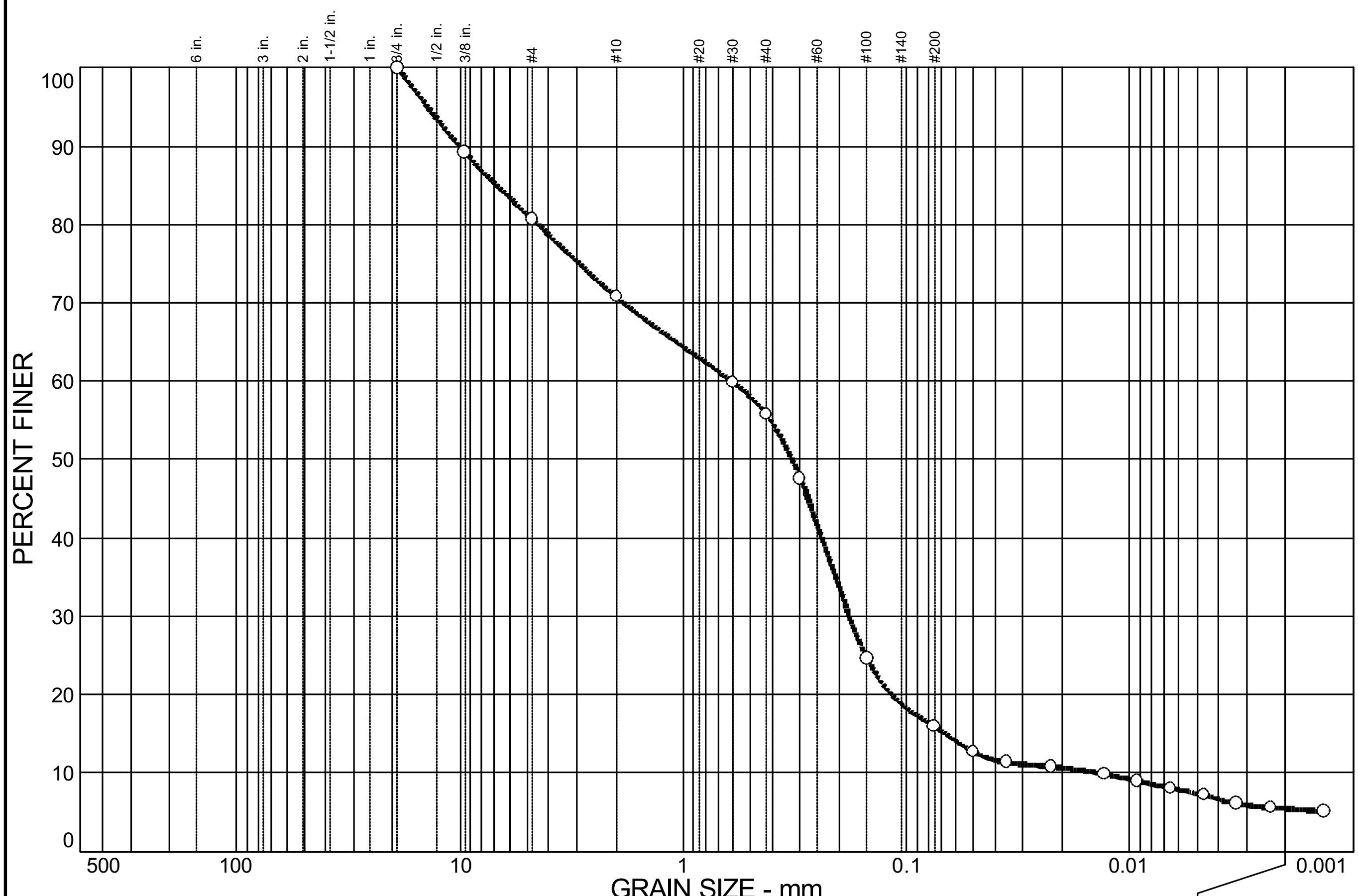
Sample No.: **Source of Sample:** TW-1 **Date:** 4/20/06
Location: **Elev./Depth:** 39.5'

COOPER TESTING LABORATORY

Client: Environmental Resources Management
Project: Hookston - 0020557.10

Project No: 586-004 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	19.3	9.9	15.0	39.8	10.5	5.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	89.2		
#4	80.7		
#10	70.8		
#30	59.9		
#40	55.8		
#50	47.6		
#100	24.6		
#200	16.0		
0.0502 mm.	12.7		
0.0358 mm.	11.4		
0.0224 mm.	10.8		
0.0130 mm.	9.9		
0.0092 mm.	9.0		
0.0066 mm.	8.1		
0.0047 mm.	7.2		
0.0033 mm.	6.1		
0.0023 mm.	5.6		
0.0013 mm.	5.1		

* (no specification provided)

Soil Description

Greenish Gray Silty SAND w/ Gravel (cemented)

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 6.86 D_{60}= 0.607 D_{50}= 0.326
D_{30}= 0.181 D_{15}= 0.0667 D_{10}= 0.0136
C_u= 44.62 C_c= 3.96

Classification

USCS= AASHTO=

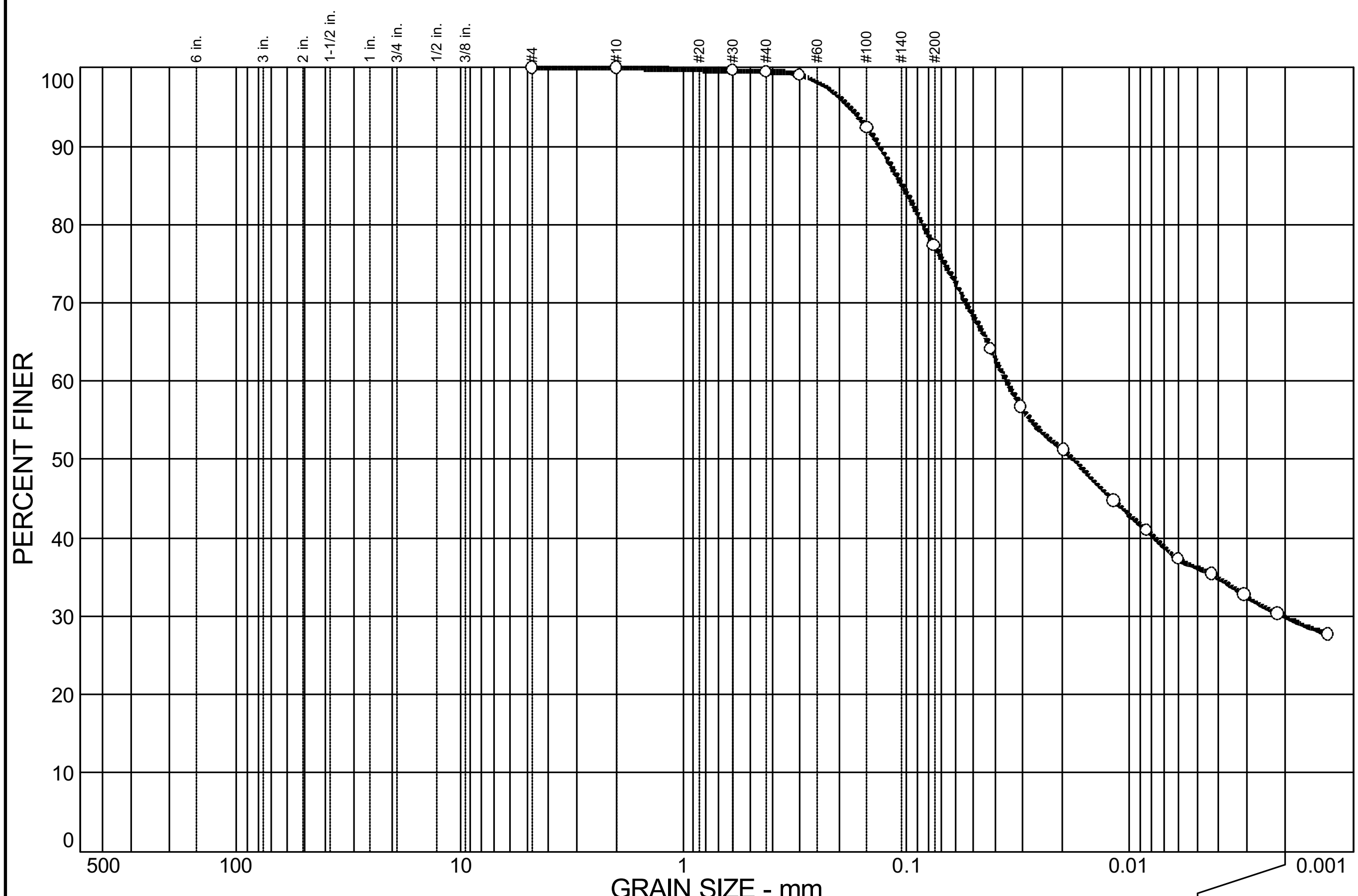
Remarks

Sample No.: **Source of Sample:** TW-1 **Date:** 4/20/06
Location: **Elev./Depth:** 46.5'

COOPER TESTING LABORATORY

Client: Environmental Resources Management
Project: Hookston - 0020557.10
Project No: 586-004 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	0.5	22.2	47.4	29.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#30	99.6		
#40	99.5		
#50	99.1		
#100	92.3		
#200	77.3		
0.0419 mm.	64.1		
0.0306 mm.	56.7		
0.0198 mm.	51.2		
0.0117 mm.	44.7		
0.0084 mm.	41.0		
0.0060 mm.	37.3		
0.0043 mm.	35.4		
0.0031 mm.	32.7		
0.0022 mm.	30.3		
0.0013 mm.	27.7		

* (no specification provided)

Soil Description

Dark Brown CLAY w/ Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.105 D_{60}= 0.0355 D_{50}= 0.0178
D_{30}= 0.0020 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

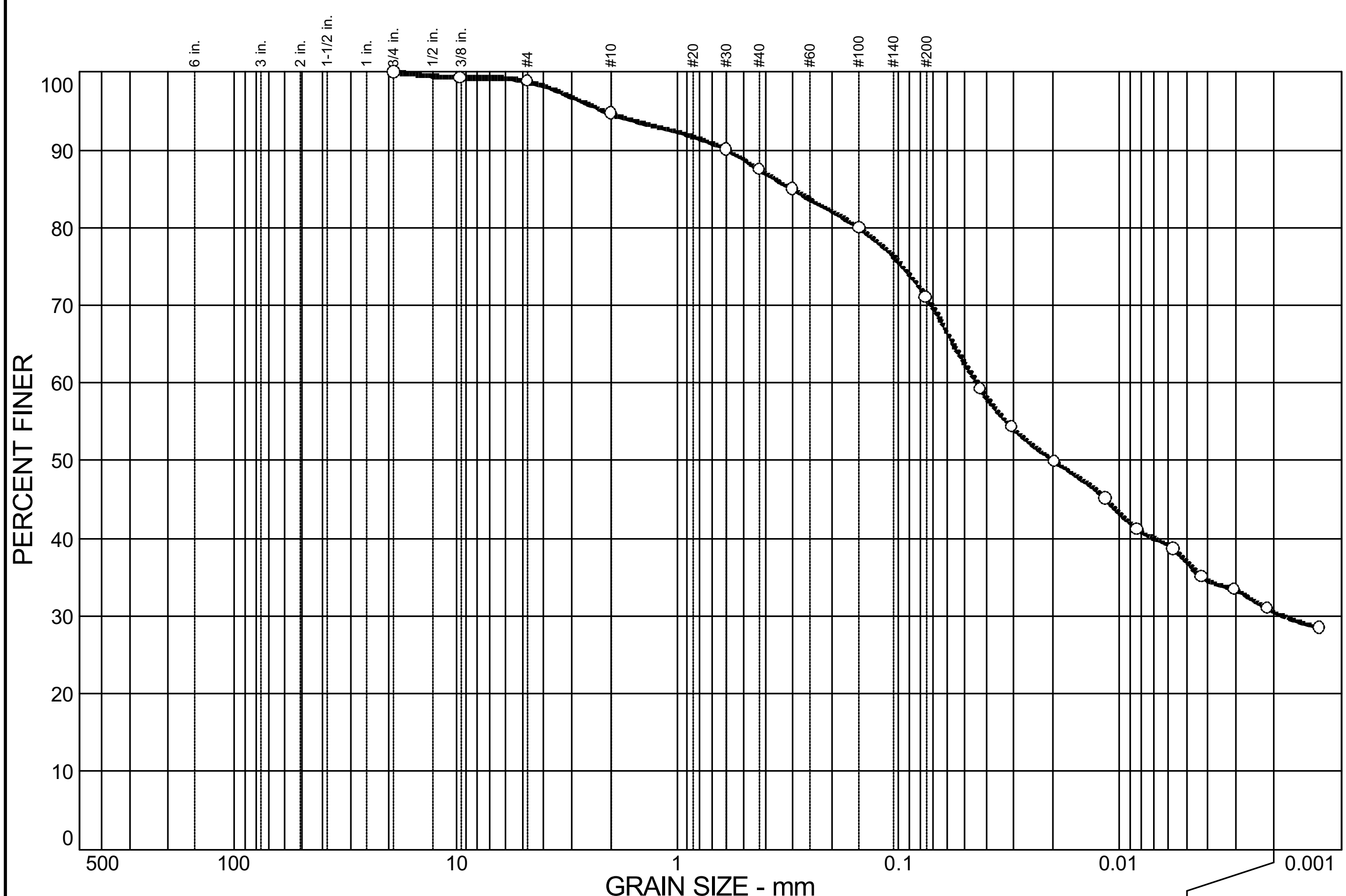
Sample No.: **Source of Sample:** TW-1 **Date:** 4/20/06
Location: **Elev./Depth:** 6.5'

COOPER TESTING LABORATORY

Client: Environmental Resources Management
Project: Hookston - 0020557.10

Project No: 586-004 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	1.2	4.1	7.2	16.5	40.5	30.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	99.3		
#4	98.8		
#10	94.7		
#30	90.0		
#40	87.5		
#50	84.9		
#100	79.9		
#200	71.0		
0.0426 mm.	59.2		
0.0308 mm.	54.4		
0.0196 mm.	49.9		
0.0116 mm.	45.1		
0.0083 mm.	41.2		
0.0057 mm.	38.6		
0.0043 mm.	35.1		
0.0030 mm.	33.4		
0.0022 mm.	31.0		
0.0012 mm.	28.5		

* (no specification provided)

Soil Description

Greenish Gray CLAY w/ Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.304 D_{60}= 0.0444 D_{50}= 0.0199
D_{30}= 0.0018 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

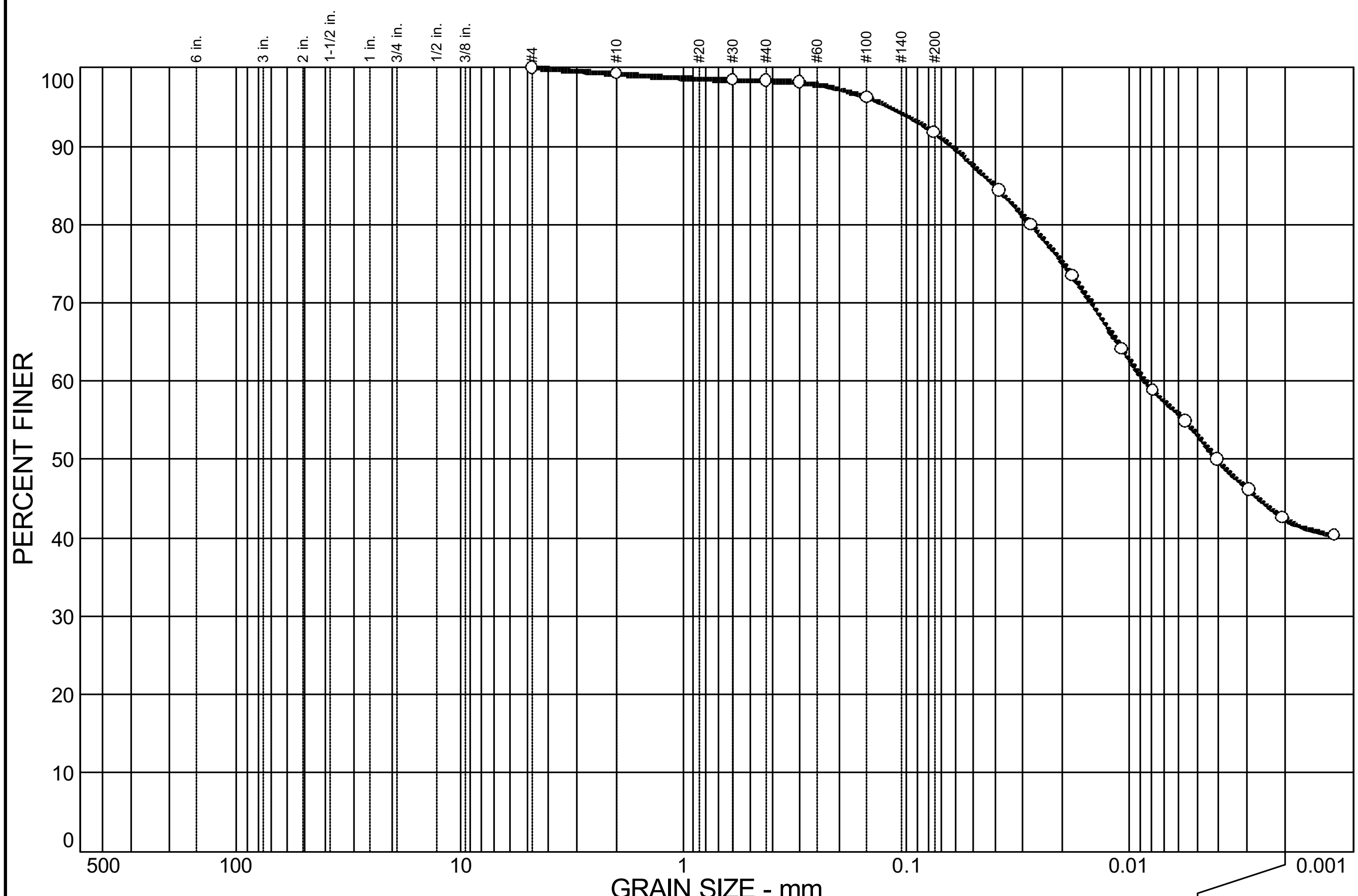
Sample No.: **Source of Sample:** TW-1 **Date:** 4/20/06
Location: **Elev./Depth:** 75'

COOPER TESTING LABORATORY

Client: Environmental Resources Management
Project: Hookston - 0020557.10

Project No: 586-004 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.8	0.9	6.6	49.3	42.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.2		
#30	98.4		
#40	98.3		
#50	98.1		
#100	96.2		
#200	91.7		
0.0383 mm.	84.3		
0.0277 mm.	80.0		
0.0180 mm.	73.4		
0.0108 mm.	64.1		
0.0078 mm.	58.8		
0.0056 mm.	54.9		
0.0041 mm.	50.0		
0.0029 mm.	46.1		
0.0021 mm.	42.6		
0.0012 mm.	40.3		

* (no specification provided)

Soil Description

Brown CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.0405 D_{60}= 0.0085 D_{50}= 0.0041
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

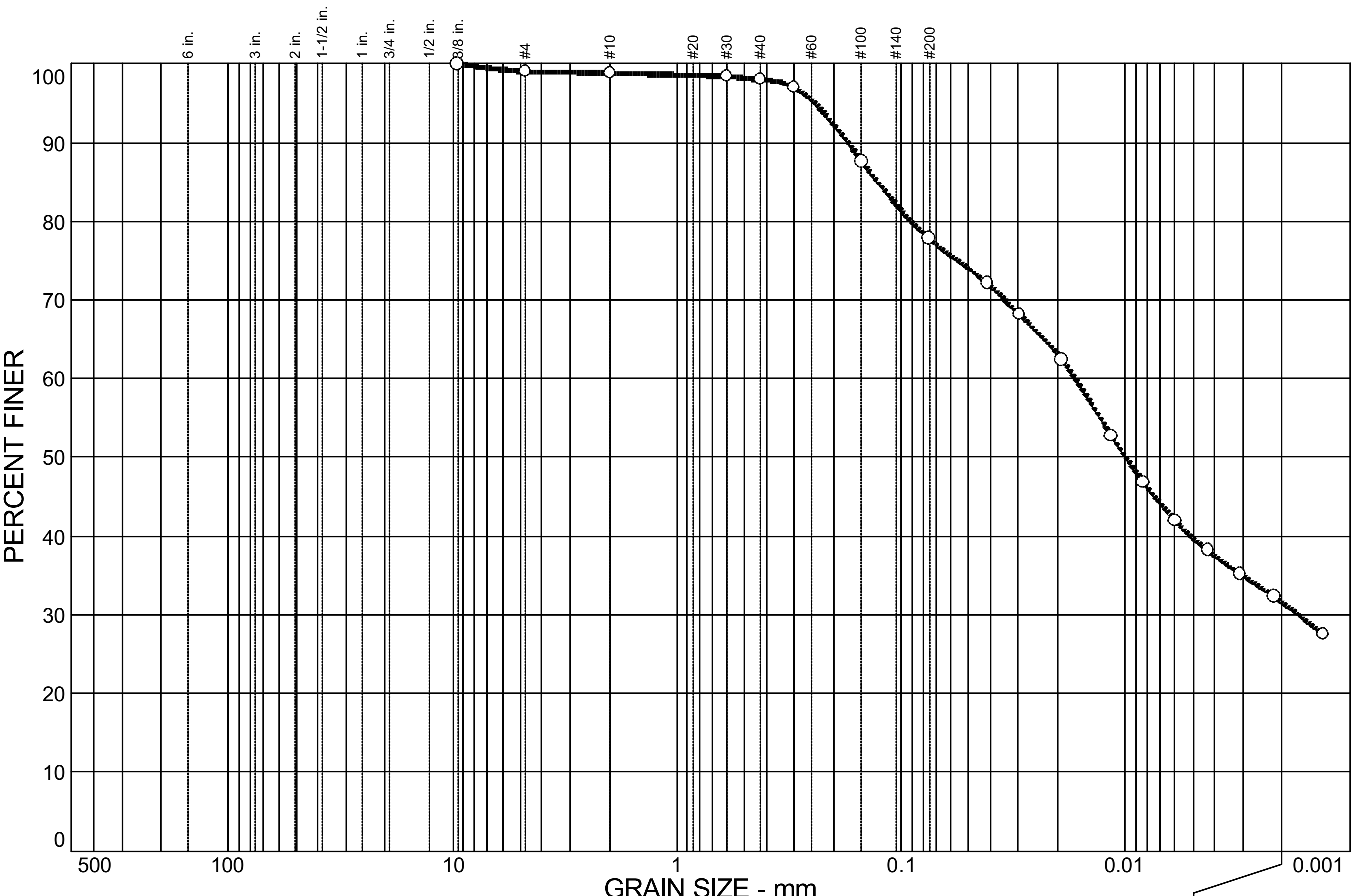
Remarks

Sample No.: **Source of Sample:** SVE-1 **Date:** 4/26/06
Location: **Elev./Depth:** 11.5'

COOPER TESTING LABORATORY

Client: Environmental Resources Management
Project: Hookston - 0020557.10
Project No: 586-005 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	1.0	0.2	0.8	20.2	46.2	31.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8 in.	100.0		
#4	99.0		
#10	98.8		
#30	98.4		
#40	98.0		
#50	97.0		
#100	87.6		
#200	77.8		
0.0412 mm.	72.1		
0.0297 mm.	68.2		
0.0192 mm.	62.4		
0.0115 mm.	52.7		
0.0083 mm.	46.9		
0.0060 mm.	42.0		
0.0043 mm.	38.2		
0.0031 mm.	35.2		
0.0022 mm.	32.3		
0.0013 mm.	27.6		

* (no specification provided)

Soil Description

Mottled Brown CLAY w/ Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.128 D_{60}= 0.0168 D_{50}= 0.0100
D_{30}= 0.0017 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

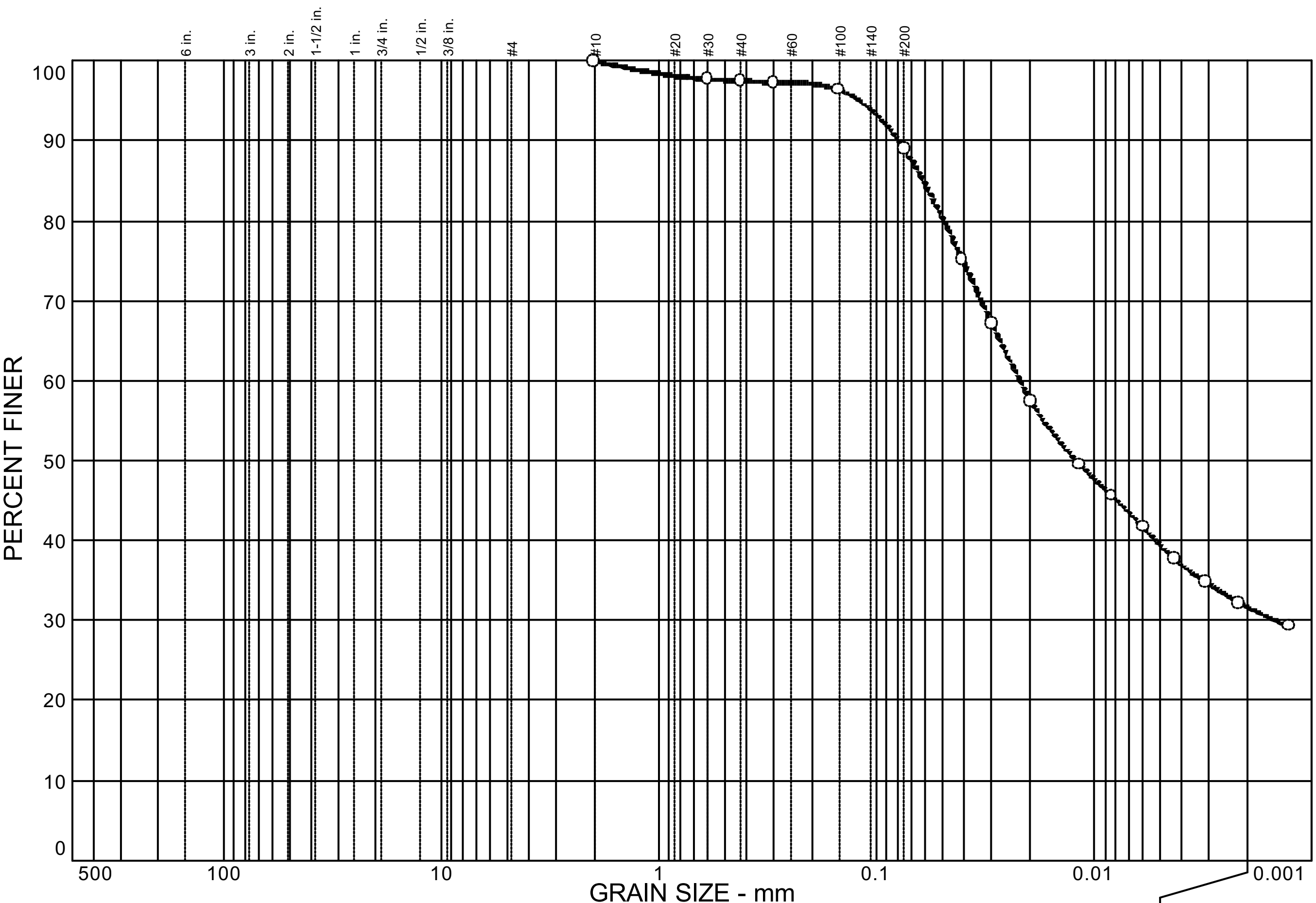
Sample No.: **Source of Sample:** TW-2 **Date:** 4/26/06
Location: **Elev./Depth:** 12'

COOPER TESTING LABORATORY

Client: Environmental Resources Management
Project: Hookston - 0020557.10

Project No: 586-005 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	11.0	57.3	31.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#30	97.7		
#40	97.5		
#50	97.3		
#100	96.4		
#200	89.0		
0.0408 mm.	75.1		
0.0298 mm.	67.2		
0.0196 mm.	57.4		
0.0117 mm.	49.5		
0.0084 mm.	45.6		
0.0060 mm.	41.7		
0.0043 mm.	37.7		
0.0031 mm.	34.8		
0.0022 mm.	32.2		
0.0013 mm.	29.3		

* (no specification provided)

Soil Description

Mottled Grayish Brown CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.0614 D_{60}= 0.0222 D_{50}= 0.0122
D_{30}= 0.0015 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

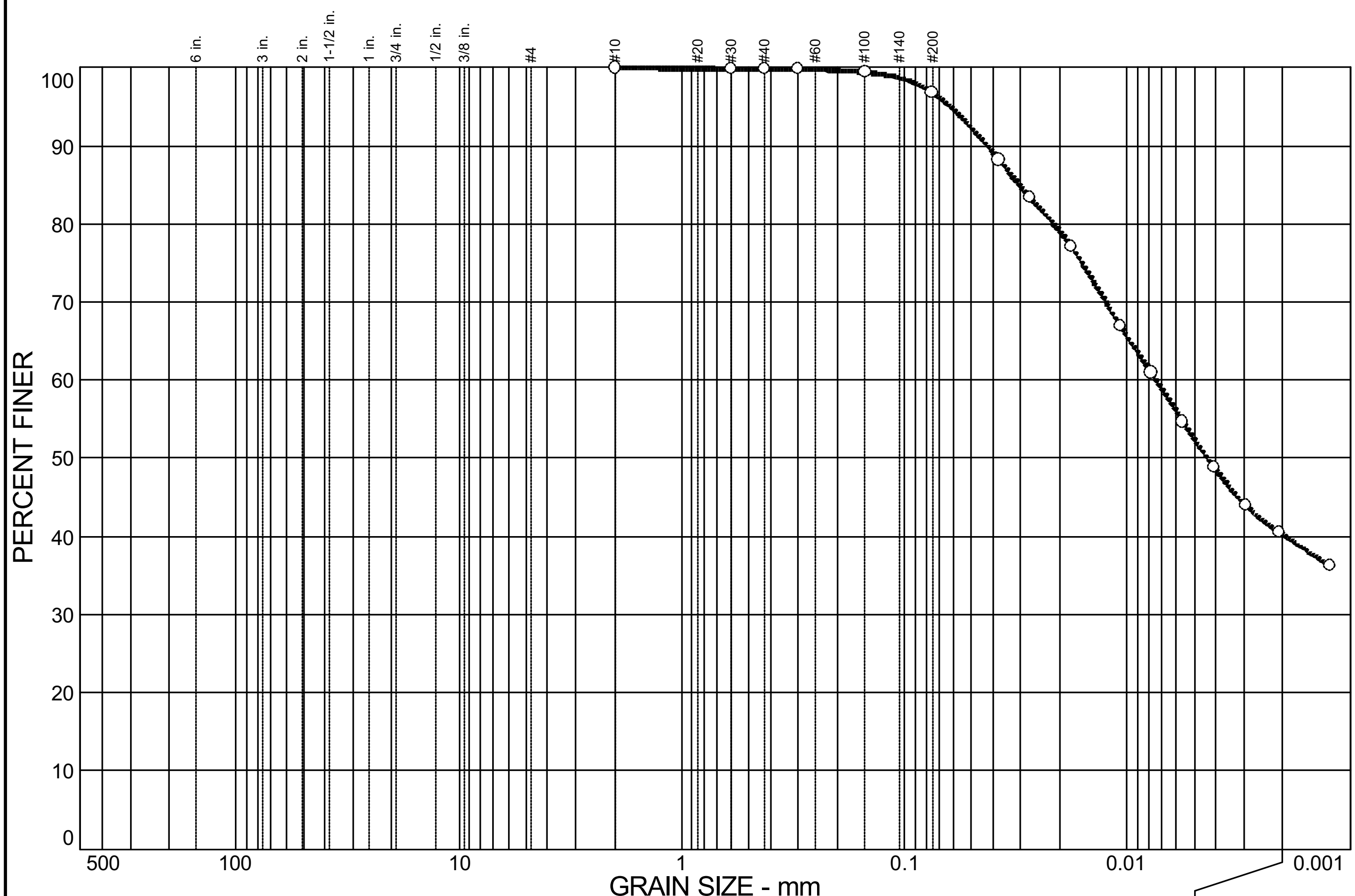
Sample No.: **Source of Sample:** TW-2-19 **Date:** 4/26/06
Location: **Elev./Depth:**

COOPER TESTING LABORATORY

Client: Environmental Resources Management
Project: Hookston - 0020557.10

Project No: 586-006 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	0.2	3.0	56.6	40.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#30	99.8		
#40	99.8		
#50	99.8		
#100	99.4		
#200	96.8		
0.0377 mm.	88.2		
0.0273 mm.	83.4		
0.0178 mm.	77.1		
0.0108 mm.	66.9		
0.0078 mm.	61.0		
0.0057 mm.	54.7		
0.0041 mm.	48.9		
0.0029 mm.	44.0		
0.0021 mm.	40.6		
0.0012 mm.	36.3		

* (no specification provided)

Soil Description

Brown SILT

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.0305 D_{60}= 0.0074 D_{50}= 0.0044
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

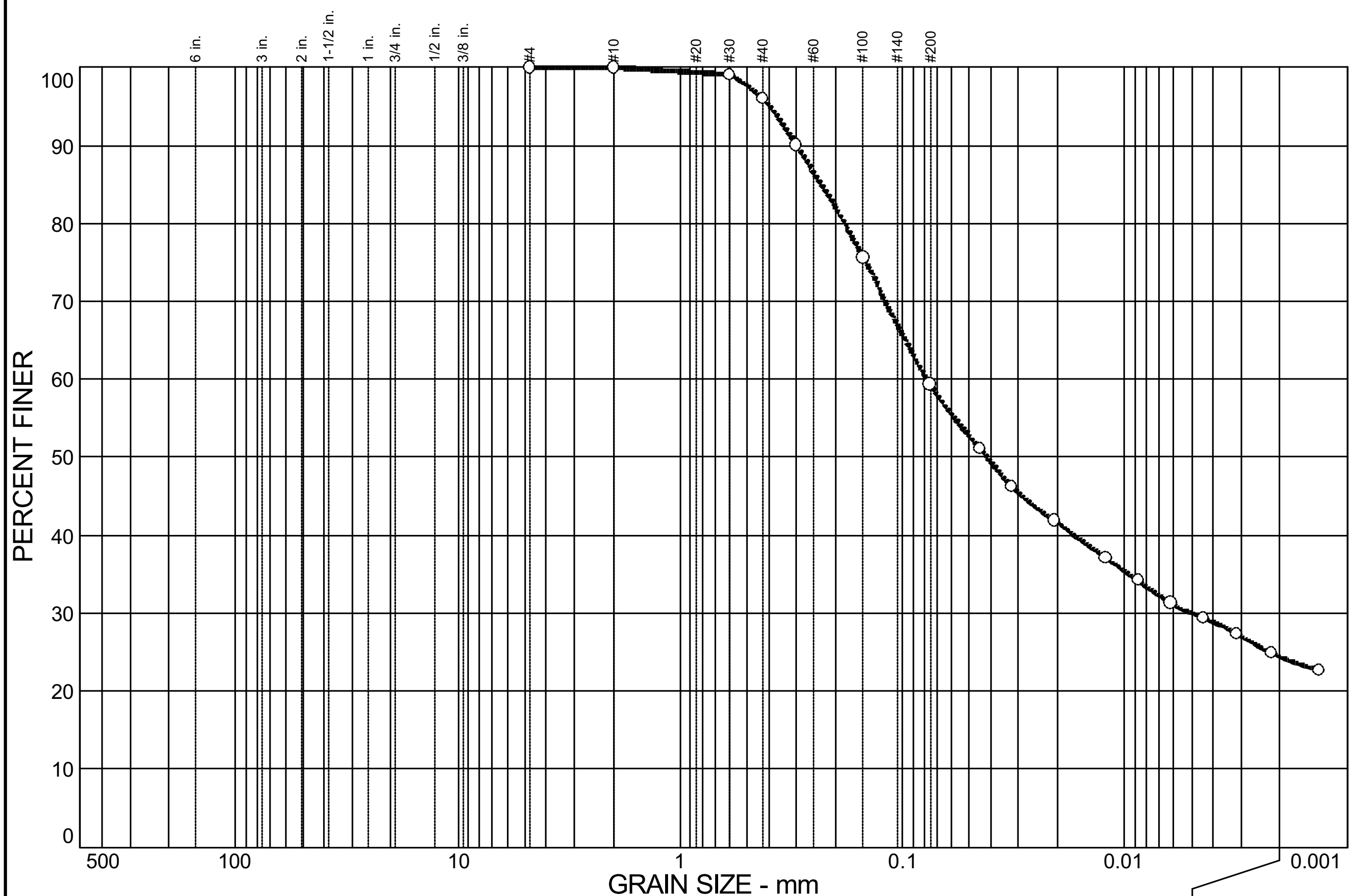
Sample No.: **Source of Sample:** TW-3 **Date:** 4/26/06
Location: **Elev./Depth:** 14.5'

COOPER TESTING LABORATORY

Client: Environmental Resources Management
Project: Hookston - 0020557.10

Project No: 586-005 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	4.0	36.7	34.9	24.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#30	99.1		
#40	96.0		
#50	90.0		
#100	75.6		
#200	59.3		
0.0448 mm.	51.1		
0.0323 mm.	46.3		
0.0207 mm.	41.9		
0.0122 mm.	37.1		
0.0087 mm.	34.2		
0.0062 mm.	31.3		
0.0044 mm.	29.4		
0.0031 mm.	27.4		
0.0022 mm.	24.9		
0.0013 mm.	22.7		

* (no specification provided)

Soil Description

Brown Sandy CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.232 D_{60}= 0.0777 D_{50}= 0.0417
D_{30}= 0.0050 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

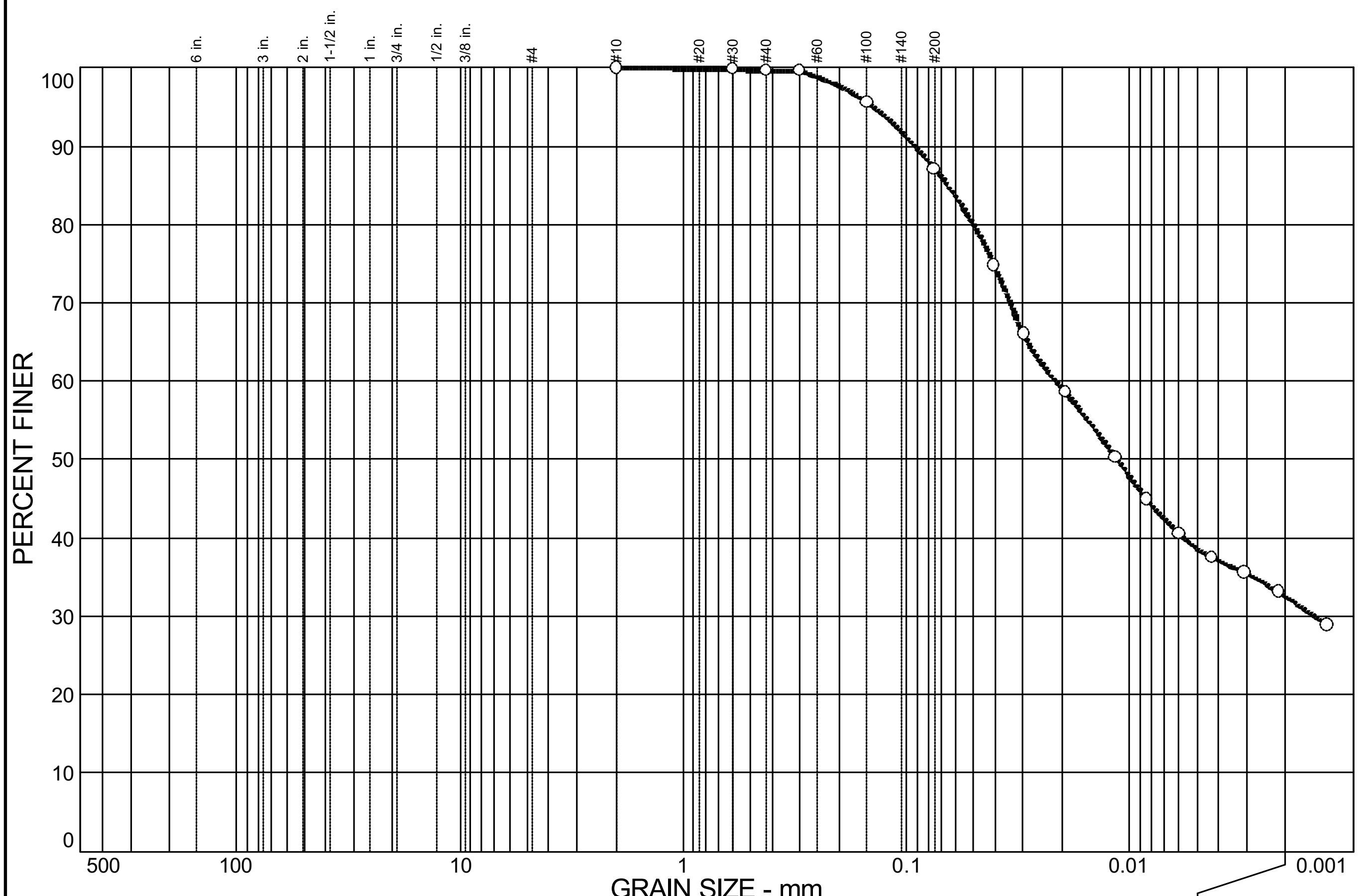
Sample No.: **Source of Sample:** TW-3 **Date:** 4/26/06
Location: **Elev./Depth:** 21.5'

COOPER TESTING LABORATORY

Client: Environmental Resources Management
Project: Hookston - 0020557.10

Project No: 586-005 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	0.4	12.5	54.6	32.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#30	99.8		
#40	99.6		
#50	99.6		
#100	95.6		
#200	87.1		
0.0406 mm.	74.8		
0.0299 mm.	66.0		
0.0195 mm.	58.6		
0.0116 mm.	50.3		
0.0084 mm.	44.9		
0.0060 mm.	40.5		
0.0043 mm.	37.5		
0.0031 mm.	35.6		
0.0022 mm.	33.1		
0.0013 mm.	28.9		

* (no specification provided)

Soil Description

Brown CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.0656 D_{60}= 0.0215 D_{50}= 0.0114
D_{30}= 0.0015 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

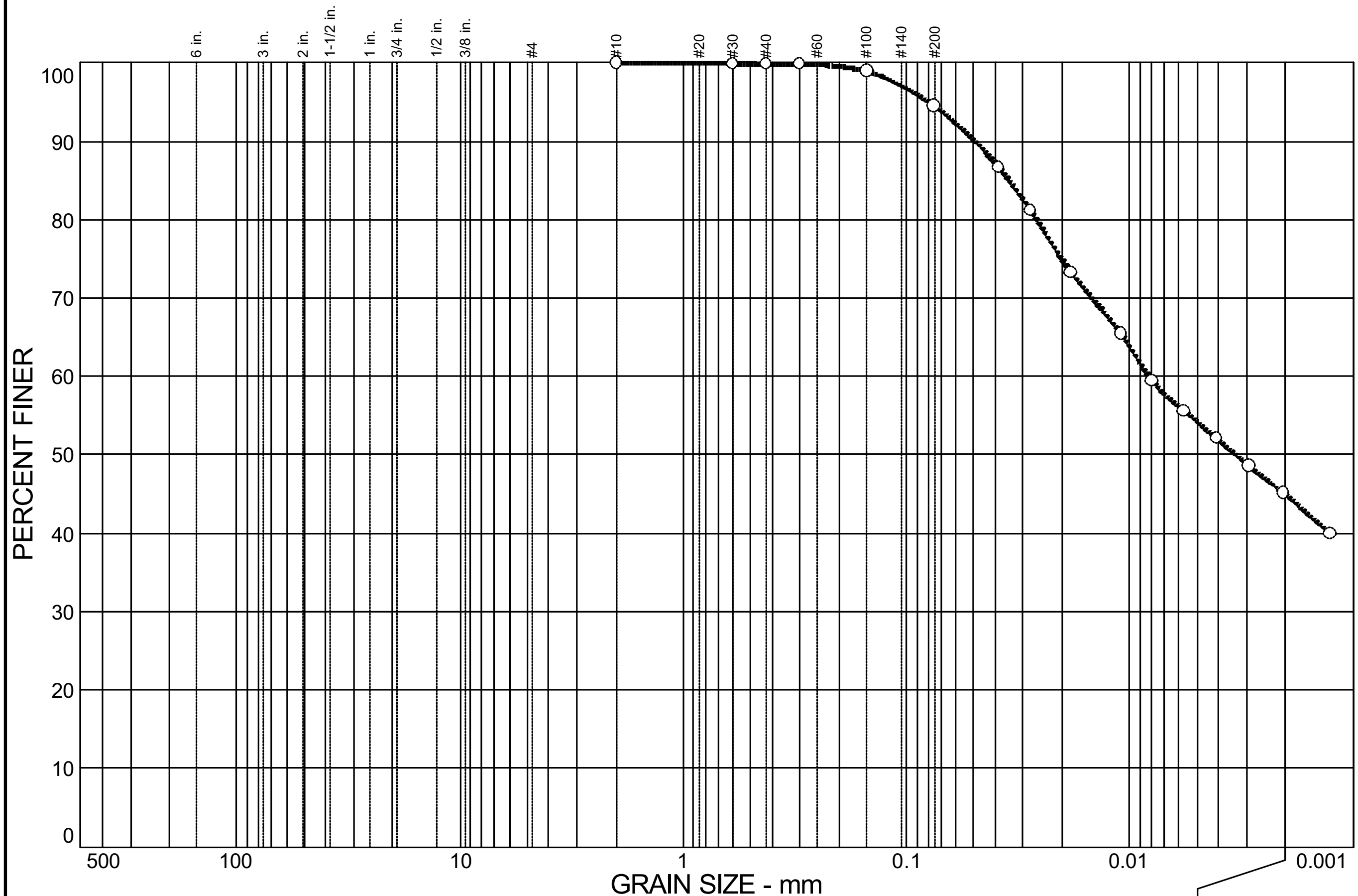
Sample No.: **Source of Sample:** TW-3 **Date:** 4/26/06
Location: **Elev./Depth:** 7.5'

COOPER TESTING LABORATORY

Client: Environmental Resources Management
Project: Hookston - 0020557.10

Project No: 586-005 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	0.2	5.3	49.6	44.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#30	99.9		
#40	99.8		
#50	99.8		
#100	98.9		
#200	94.5		
0.0385 mm.	86.6		
0.0280 mm.	81.2		
0.0183 mm.	73.3		
0.0109 mm.	65.4		
0.0079 mm.	59.5		
0.0057 mm.	55.6		
0.0041 mm.	52.1		
0.0029 mm.	48.6		
0.0020 mm.	45.1		
0.0013 mm.	39.9		

* (no specification provided)

Soil Description

Brown CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.0348 D_{60}= 0.0082 D_{50}= 0.0033
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

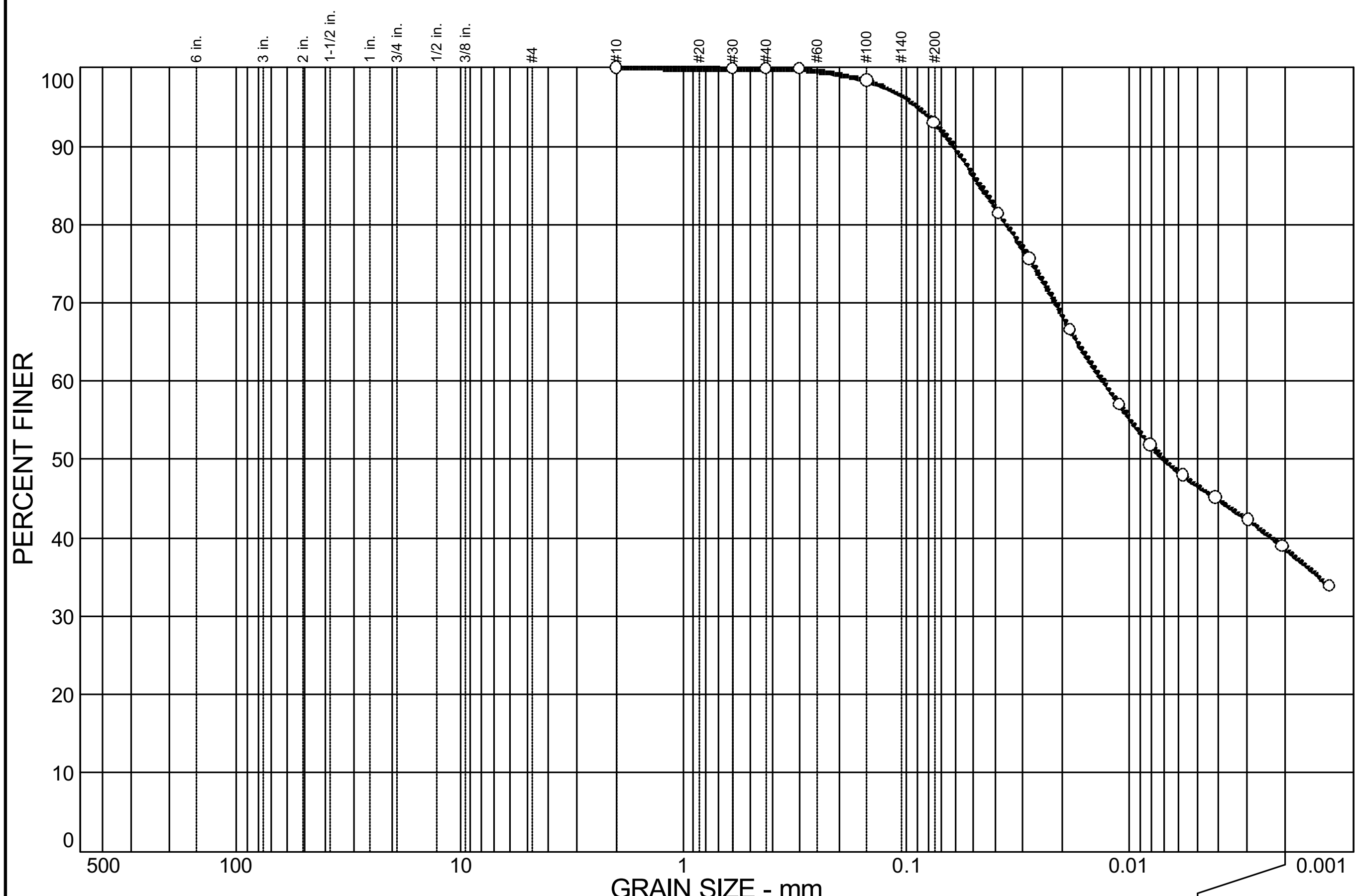
Sample No.: **Source of Sample:** TW-4 **Date:** 4/26/06
Location: **Elev./Depth:** 17'

COOPER TESTING LABORATORY

Client: Environmental Resources Management
Project: Hookston - 0020557.10

Project No: 586-005 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	0.2	6.8	54.4	38.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#30	99.8		
#40	99.8		
#50	99.8		
#100	98.3		
#200	93.0		
0.0386 mm.	81.4		
0.0281 mm.	75.6		
0.0185 mm.	66.6		
0.0111 mm.	57.0		
0.0080 mm.	51.8		
0.0058 mm.	48.0		
0.0041 mm.	45.1		
0.0029 mm.	42.3		
0.0021 mm.	38.9		
0.0013 mm.	33.8		

* (no specification provided)

Soil Description

Brown CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.0469 D_{60}= 0.0132 D_{50}= 0.0070
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Sample No.: **Source of Sample:** TW-4 **Date:** 4/26/06
Location: **Elev./Depth:** 7.5'

COOPER TESTING LABORATORY

Client: Environmental Resources Management
Project: Hookston - 0020557.10

Project No: 586-005 **Figure**

COOPER TESTING LABORATORY

Specific Gravity by Pycnometer

ASTM D 854m

CTL Job#:	586-004	**Project Name:**	Hookston	**Date:**	04/18/06
Client:	Environmental Resources Management	**Project No.:**	20557.1	**Run By:**	MD
				Checked	DC

Boring:	TW-1	TW-1	TW-1	TW-1	TW-1	TW-1		
Sample:								
Depth, ft.:	6.5	10	30	39.5	46.5	75		
Pan No.:								
Soil Description (visual)	Dark Brown CLAY w/ Sand	Mottled Light Brown Sandy CLAY	Greenish Gray CLAY w/ Sand	Dark Gray CLAY	Greenish Gray Silty SAND w/ Gravel (cemented)	Greenish Gray CLAY w/ Sand		
Dish No.								
Air-Dry Weight, gm	30.16	36.08	31.06	22.35	30.32	37.59		
Oven-Dry Weight., gm	29.57	35.58	30.75	22.05	30.10	37.30		
Dish Weight, gm	11.43	11.36	11.43	11.36	11.73	11.72		
Hydroscopic MC, %	3.3	2.1	1.6	2.8	1.2	1.1		
Pycnometer No.:								
Wt Pycn., Soil & H2O (Wb), g	716.7	723.0	711.1	707.6	725.3	723.8		
Test Temp. (T), °C	20.4	20.4	21.0	21.0	21.0	21.6		
Wt Pycn. & H2O @ T (Wa), g	662.8	671.5	662.8	671.5	680.9	671.4		
Wt of Air-Dried Soil (Wm), g	88.02	83.4	77.86	58.74	71.2	83.83		
Wt of Oven-Dried Soil (Wo), g	85.25	81.71	76.63	57.14	70.36	82.89		
Temp. Corr. Factor (K)	1.0006	1.0006	0.9998	0.9998	0.9998	0.9998		
Specific Gravity (20°C) $Gs = \frac{K\ Wo}{Wo+Wa-Wb}$	**2.72**	**2.71**	**2.71**	**2.72**	**2.71**	**2.72**		

Specific Gravity by Pycnometer

ASTM D 854m

CTL Job#:	586-005	**Project Name:**	Hookston	**Date:**	04/26/06
Client:	Environmental Resources Management	**Project No.:**	20557.1	**Run By:**	MD
				Checked	DC

Boring:	TW-2	TW-3	TW-3	TW-3	TW-4	TW-4	SVE-1	
Sample:								
Depth, ft.:	12	7.5	14.5	21.5	17	7.5	11.5	
Pan No.:								
Soil Description (visual)	Mottled Brown CLAY w/ Sand	Brown CLAY	Brown SILT	Brown Sandy CLAY	Brown CLAY	Brown CLAY	Brown CLAY	
Dish No.								
Air-Dry Weight, gm	36.60	30.16	30.53	31.26	33.62	34.08	33.32	
Oven-Dry Weight., gm	36.40	30.04	30.14	30.96	33.29	33.74	32.73	
Dish Weight, gm	11.72	11.72	11.72	11.72	11.72	11.78	11.78	
Hydroscopic MC, %	0.8	0.7	2.1	1.6	1.5	1.5	2.8	
Pycnometer No.:								
Wt Pycn., Soil & H2O (Wb), g	714.6	721.9	715.1	713.0	720.8	731.3	728.0	
Test Temp. (T), °C	21.4	21.4	21.6	21.6	21.6	21.6	21.6	
Wt Pycn. & H2O @ T (Wa), g	662.7	671.4	662.7	662.7	671.4	680.8	680.8	
Wt of Air-Dried Soil (Wm), g	83.09	80.29	84.17	81	79.24	80.56	76.04	
Wt of Oven-Dried Soil (Wo), g	82.42	79.77	82.42	79.76	78.05	79.33	73.96	
Temp. Corr. Factor (K)	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	
Specific Gravity (20°C) $G_s = \frac{K\,W_o}{W_o+W_a-W_b}$	**2.70**	**2.72**	**2.74**	**2.71**	**2.72**	**2.75**	**2.76**	

COOPER TESTING LABORATORY

Specific Gravity by Pycnometer

ASTM D 854m

CTL Job#:	586-006	**Project Name:**	Hookston	**Date:**	04/24/06
Client:	Environmental Resources Management	**Project No.:**	20557.1	**Run By:**	MD
				Checked	DC

Boring:	TW-2-19							
Sample:								
Depth, ft.:								
Pan No.:								
Soil Description (visual)	Mottled Grayish Brown CLAY							
Dish No.								
Air-Dry Weight, gm	31.16							
Oven-Dry Weight., gm	30.78							
Dish Weight, gm	11.44							
Hydroscopic MC, %	2.0							
Pycnometer No.:								
Wt Pycn., Soil & H2O (Wb), g	720.6							
Test Temp. (T), ^{o}C	21.1							
Wt Pycn. & H2O @ T (Wa), g	662.8							
Wt of Air-Dried Soil (Wm), g	93.37							
Wt of Oven-Dried Soil (Wo), g	91.58							
Temp. Corr. Factor (K)	0.9998							
Specific Gravity (20^{o}C) $Gs = \frac{K\ Wo}{Wo+Wa-Wb}$	**2.71**							

Hydraulic Conductivity
ASTM D 5084
Method C: Falling Head Rising Tailwater

Job No:	586-004	**Boring:**	TW-1	**Date:**	04/26/06
Client:	Environmental Resources Management	**Sample:**		**By:**	MD/PJ
Project:	Hookston - 0020557.10	**Depth, ft.:**	30	**Remolded:**	

Visual Classification: Greenish Gray CLAY w/ sand

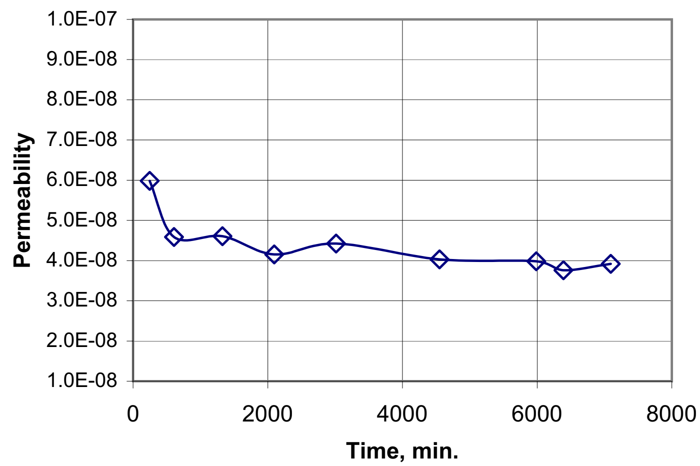
Max Sample Pressures, psi:

Cell:	Bottom	Top	Avg. Sigma 3
43.5	39.5	37.5	5

B: = >0.95 **("B" is an indication of saturation)**

Max Hydraulic Gradient: = 27

Date	Minutes	Head, (in)	K,cm/sec
4/13/2006	0.00	79.38	Start of Test
4/13/2006	247.00	78.88	6.0E-08
4/13/2006	607.00	78.38	4.6E-08
4/14/2006	1328.00	77.28	4.6E-08
4/14/2006	2096.00	76.48	4.2E-08
4/15/2006	3014.00	75.18	4.4E-08
4/16/2006	4550.00	73.53	4.0E-08
4/17/2006	5987.00	72.03	4.0E-08
4/17/2006	6390.00	71.63	3.8E-08
4/18/2006	7092.00	70.88	3.9E-08



Average Permeability: **4.E-08** **cm/sec**

Sample Data:	Initial	Final
Height, in	2.98	2.98
Diameter, in	1.94	1.94
Area, in2	2.94	2.94
Volume in3	8.77	8.77
Total Volume, cc	143.7	143.7
Volume Solids, cc	82.3	82.3
Volume Voids, cc	61.4	61.4
Void Ratio	0.7	0.7
Porosity, %	42.7	42.7
Saturation, %	99.0	99.3
Specific Gravity	2.71	2.71
Wet Weight, gm	283.8	284.0
Dry Weight, gm	223.0	223.0
Tare, gm	0.00	0.00
Moisture, %	27.3	27.4
Dry Density, pcf	96.8	96.8

Remarks:

Hydraulic Conductivity
ASTM D 5084
Method C: Falling Head Rising Tailwater

Job No:	586-004	**Boring:**	TW-1	**Date:**	04/26/06
Client:	Environmental Resources Managment	**Sample:**		**By:**	MD/PJ
Project:	Hookston - 0020557.10	**Depth, ft.:**	39.5	**Remolded:**	

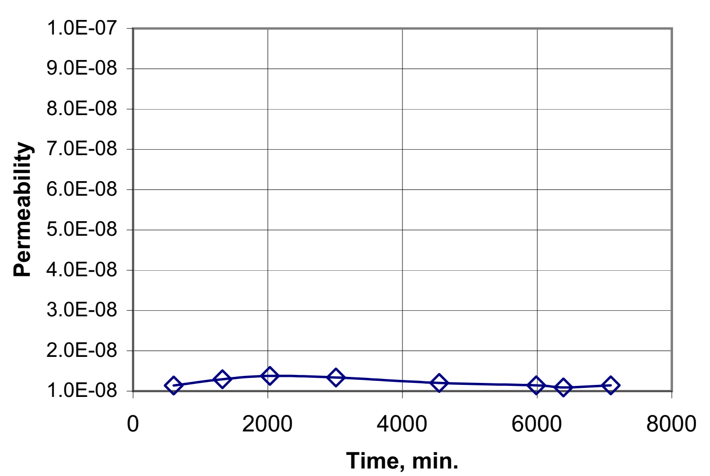
Visual Classification: Dark Gray CLAY

Max Sample Pressures, psi:			
Cell:	**Bottom**	**Top**	**Avg. Sigma 3**
53.5	49.5	47.5	5

B: = >0.95 **("B" is an indication of saturation)**

Max Hydraulic Gradient: = 27

Date	Minutes	Head, (in)	K,cm/sec
4/13/2006	0.00	79.38	**Start of Test**
4/13/2006	604.00	79.13	1.1E-08
4/14/2006	1328.00	78.78	1.3E-08
4/14/2006	2033.00	78.43	1.4E-08
4/15/2006	3013.00	78.08	1.3E-08
4/16/2006	4546.00	77.58	1.2E-08
4/17/2006	5987.00	77.18	1.1E-08
4/17/2006	6390.00	77.03	1.1E-08
4/18/2006	7092.00	76.78	1.1E-08



Average Permeability: **1.E-08** **cm/sec**

Sample Data:	Initial	Final
Height, in	2.99	3.04
Diameter, in	1.94	1.96
Area, in2	2.94	3.02
Volume in3	8.78	9.17
Total Volume, cc	143.8	150.3
Volume Solids, cc	75.1	75.1
Volume Voids, cc	68.8	75.2
Void Ratio	0.9	1.0
Porosity, %	47.8	50.1
Saturation, %	98.6	99.3
Specific Gravity	2.72	2.72
Wet Weight, gm	272.0	278.9
Dry Weight, gm	204.2	204.2
Tare, gm	0.00	0.00
Moisture, %	33.2	36.6
Dry Density, pcf	88.6	84.8

Remarks:

COOPER TESTING LABORATORY

Hydraulic Conductivity
ASTM D 5084
Method C: Falling Head Rising Tailwater

Job No:	586-004	**Boring:**	TW-1	**Date:**	04/26/06
Client:	Environmental Resources Management	**Sample:**		**By:**	MD/PJ
Project:	Hookston - 0020557.10	**Depth, ft.:**	46.5	**Remolded:**	

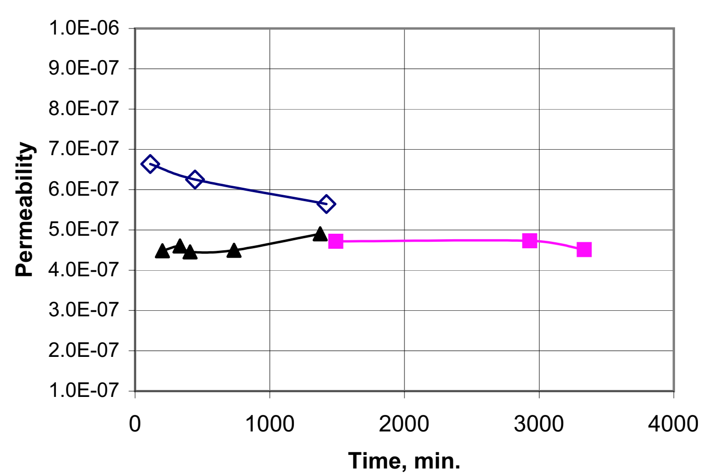
Visual Classification: Greenish Gray Silty SAND w/ Gravel (cemented)

B: = >0.95 (**"B" is an indication of saturation**)

Max Hydraulic Gradient: = 13

Max Sample Pressures, psi:			
Cell:	**Bottom**	**Top**	**Avg. Sigma 3**
63.5	59	58	5

Date	Minutes	Head, (in)	K,cm/sec
4/14/2006	0.00	94.63	**Start of Test**
4/14/2006	113.00	92.23	6.6E-07
4/14/2006	445.00	86.03	6.3E-07
4/15/2006	1421.00	72.83	5.6E-07
4/16/2006	1491.00	77.73	4.7E-07
4/17/2006	2931.00	62.53	4.7E-07
4/17/2006	3335.00	58.73	4.5E-07
4/18/2006	203.00	94.73	4.5E-07
4/18/2006	333.00	92.73	4.6E-07
4/18/2006	408.00	91.83	4.5E-07
4/18/2006	735.00	87.03	4.5E-07
4/19/2006	1374.00	78.43	4.9E-07



Average Permeability: 5.E-07 cm/sec

Sample Data:	Initial	Final
Height, in	2.99	2.89
Diameter, in	1.94	1.94
Area, in2	2.94	2.96
Volume in3	8.79	8.54
Total Volume, cc	144.1	140.0
Volume Solids, cc	96.3	96.3
Volume Voids, cc	47.7	43.6
Void Ratio	0.5	0.5
Porosity, %	33.1	31.2
Saturation, %	98.9	99.4
Specific Gravity	2.71	2.71
Wet Weight, gm	308.3	304.5
Dry Weight, gm	261.1	261.1
Tare, gm	0.00	0.00
Moisture, %	18.1	16.6
Dry Density, pcf	113.1	116.4

Remarks: This sample contained a 2" diameter rock. This probably had a significant impact on the measured permeability.

Hydraulic Conductivity
ASTM D 5084
Method C: Falling Head Rising Tailwater

Job No:	586-004	**Boring:**	TW-1	**Date:**	04/26/06
Client:	Environmental Resources Management	**Sample:**		**By:**	MD/PJ
Project:	Hookston - 0020557.10	**Depth, ft.:**	75	**Remolded:**	

Visual Classification: Greenish Gray CLAY w/ Sand

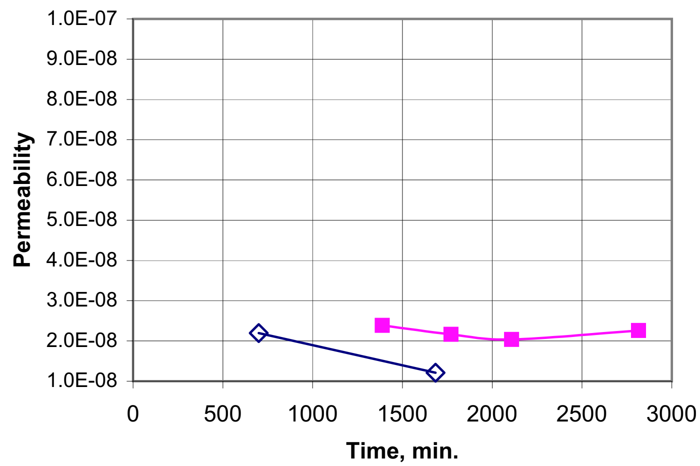
Max Sample Pressures, psi:

Cell:	Bottom	Top	Avg. Sigma 3
53.5	49.5	47.5	5

B: = >0.95 **("B" is an indication of saturation)**

Max Hydraulic Gradient: = 22

Date	Minutes	Head, (in)	K,cm/sec
4/14/2006	0.00	168.67	**Start of Test**
4/14/2006	700.00	166.76	2.2E-08
4/15/2006	1684.00	166.26	1.2E-08
4/20/2006	1388.00	164.86	2.4E-08
4/20/2006	1771.00	164.06	2.2E-08
4/20/2006	2108.00	163.26	2.0E-08
4/21/2006	2815.00	161.26	2.3E-08



Average Permeability: 2.E-08 cm/sec

Sample Data:	Initial	Final
Height, in	2.96	2.99
Diameter, in	2.88	2.90
Area, in2	6.51	6.61
Volume in3	19.28	19.72
Total Volume, cc	316.0	323.2
Volume Solids, cc	191.1	191.1
Volume Voids, cc	124.9	132.1
Void Ratio	0.7	0.7
Porosity, %	39.5	40.9
Saturation, %	95.9	97.9
Specific Gravity	2.72	2.72
Wet Weight, gm	639.6	649.1
Dry Weight, gm	519.8	519.8
Tare, gm	0.00	0.00
Moisture, %	23.0	24.9
Dry Density, pcf	102.6	100.4

Remarks:

Soil and Plant Laboratory, Inc.

www.soilandplantlaboratory.com

352 Mathew Street
Santa Clara, CA 95050
408-727-0330 phone
408-727-5125 fax

COOPER TESTING LABS
937 Commercial St
Palo Alto, CA 94303

Samples Rec'd: 4/17/06

Santa Clara Office
Lab No. 70265
ERM
586-004

Sample #	Analysis Requested	Quantity	Units	Sample Description & Log Number	
11	Chemical Organic	0.2	% dry wt	TW-1-6.5	06-A6842 20
12	Chemical Organic	< 0.1	% dry wt	TW-1-10	06-A6843 20
13	Chemical Organic	< 0.1	% dry wt	TW-1-30	06-A6844 20
14	Chemical Organic	0.3	% dry wt	TW-1-39.5	06-A6845 20
15	Chemical Organic	< 0.1	% dry wt	TW-1-46.5	06-A6846 20
16	Chemical Organic	< 0.1	% dry wt	TW-1-75	06-A6847 20

4/19/06

Soil and Plant Laboratory, Inc.

www.soilandplantlaboratory.com

352 Mathew Street
Santa Clara, CA 95050
408-727-0330 phone
408-727-5125 fax

COOPER TESTING LABS INC
937 Commercial Street
Palo Alto, CA 94303

Santa Clara Office
Lab No. 70313
ENVIRONMENTAL RESOURSES MANAGEMENT
HOOKSTON
Job No. 586-005

Samples Rec'd: 4/20/06

Sample #	Analysis Requested	Quantity	Units	Sample Description & Log Number	
1	Chemical Organic	< 0.1	% dry wt	TW-2-12	06-A7088 20
2	Chemical Organic	0.3	% dry wt	TW-3-7.5	06-A7089 20
3	Chemical Organic	0.7	% dry wt	TW-3-14.5	06-A7090 20
4	Chemical Organic	< 0.1	% dry wt	TW-3-21.5	06-A7091 20
5	Chemical Organic	0.6	% dry wt	TW-4-17	06-A7092 20
6	Chemical Organic	0.4	% dry wt	TW-4-7.5	06-A7093 20
7	Chemical Organic	0.1	% dry wt	SVE-1-11.5	06-A7094 20
8	Chemical Organic	< 0.1	% dry wt	TW-2-19	06-A7095 20

4/25/06